HIGH PERFORMANCE CONCRETE SURVEY RESULTS

Virginia Division

BY: CLAUDE S. NAPIER, Jr., P.E.
Division Bridge Engineer &
Rodolfo (Rudy) F. Maruri, P.E.
Assistant Division Bridge Engineer

U.S. Department of Transportation
Federal Highway Administration

QUESTIONNAIRE

- Prepared by a task force of the FHWA High Performance Concrete Technology Delivery Team.
- Members of task force
  - State DOT
  - Industry
  - FHWA

QUESTIONNAIRE

- Developed to compile the most up-to-date information on HPC implementation over the past 10 years
- Serve as appropriate follow-up to earlier efforts conducted by the SHRP Lead States Team for HPC, and by former FHWA Region 3.

PLAN USAGE OF THE SURVEY RESULTS

- Identify and compile various best practices on a national basis
- Identify States who may need additional assistance with implementing HPC
- Assess how far the HPC implementation program has come in relation to the 2002 FHWA goal of at least 1 HPC bridge built by each State.

HPC QUESTIONNAIRE SENT TO

- 50 STATES
- DISTRICT OF COLUMBIA
- PUERTO RICO
- FEDERAL LANDS HIGHWAY

HPC SURVEY – 14 QUESTIONS

- QUESTION 1 – Addressed Changes to Concrete Specifications
  - o Changes Made in Last 10 Years
  - o Included in current specifications

HPC SURVEY – QUESTION 1

- Types of Changes
  - HPC – low permeability usage
  - HPC – high strength concrete usage
  - Admixtures
  - Bridge deck curing & finishing
  - Cement/alkali content limit
  - Testing & acceptance requirements
  - Usage of LWC, SCC, and flowing concrete
  - Usage of reinforcing steel

HPC SURVEY – QUESTION 2

- **Question 2**
  - Current concrete specifications requirements

HPC SURVEY – QUESTION 3

- **Question 3**
  - Ranking of concrete distresses experienced

HPC SURVEY – Question 4

- Construction requirements
- Workability requirements
- Admixtures & Slag Usage
  - o Non-aggressive environments
  - o Aggressive environments
  - o Elements where used

HPC SURVEY – Question 4 (Cont.)

- Admixture Type & Slag – Amount used
- Job site additions to concrete
- Finishing requirements
- Curing Requirements
- Evaporation requirements

HPC SURVEY – Question 5

QUESTION 5

- Fiber reinforced concrete usage

HPC SURVEY – Question 6

QUESTION 6

- Concrete cover requirements
- Minimum concrete cover requirements
  - Non- aggressive environment
  - Aggressive environment
- Structural elements - required reinforcing steel
  - Non-aggressive environments
  - Aggressive environments
  - Experimental Use

HPC SURVEY – Question 7

QUESTION 7

- Percent alkali allowed in cement

HPC SURVEY – Question 8

QUESTION 8

- Testing for reactivity of aggregates

HPC SURVEY – Question 9

QUESTION 9

- Structural elements - permeability requirement limits
- Non-aggressive environment
- Aggressive environment

HPC SURVEY – Question 10

- QC/QA Tests
  - Fresh concrete
  - Hardened concrete
- Acceptance criteria for cracks
- Pre-construction mock-up requirements
- Design Properties – 28 or 56 days

HPC SURVEY – Question 10

- Compressive strength tests
- Cylinder end-cap requirements
- Match-cured cylinder requirements
- Wet-water curing monitoring
- Warrantees
- Microwave Test for w/cm experience

HPC SURVEY – Question 11

QUESTION 11

- Types of overlays used
- Performance of overlays

HPC SURVEY – Question 12

QUESTION 12

- Interest in beneficial attributes of HPC
- Overall ranking of beneficial attributes

HPC SURVEY – Question 13

QUESTION 13

- Who is involved in examining concrete specifications and procedures

HPC SURVEY – Question 14

QUESTION 14

- Adoption/implementation of various SHRP products

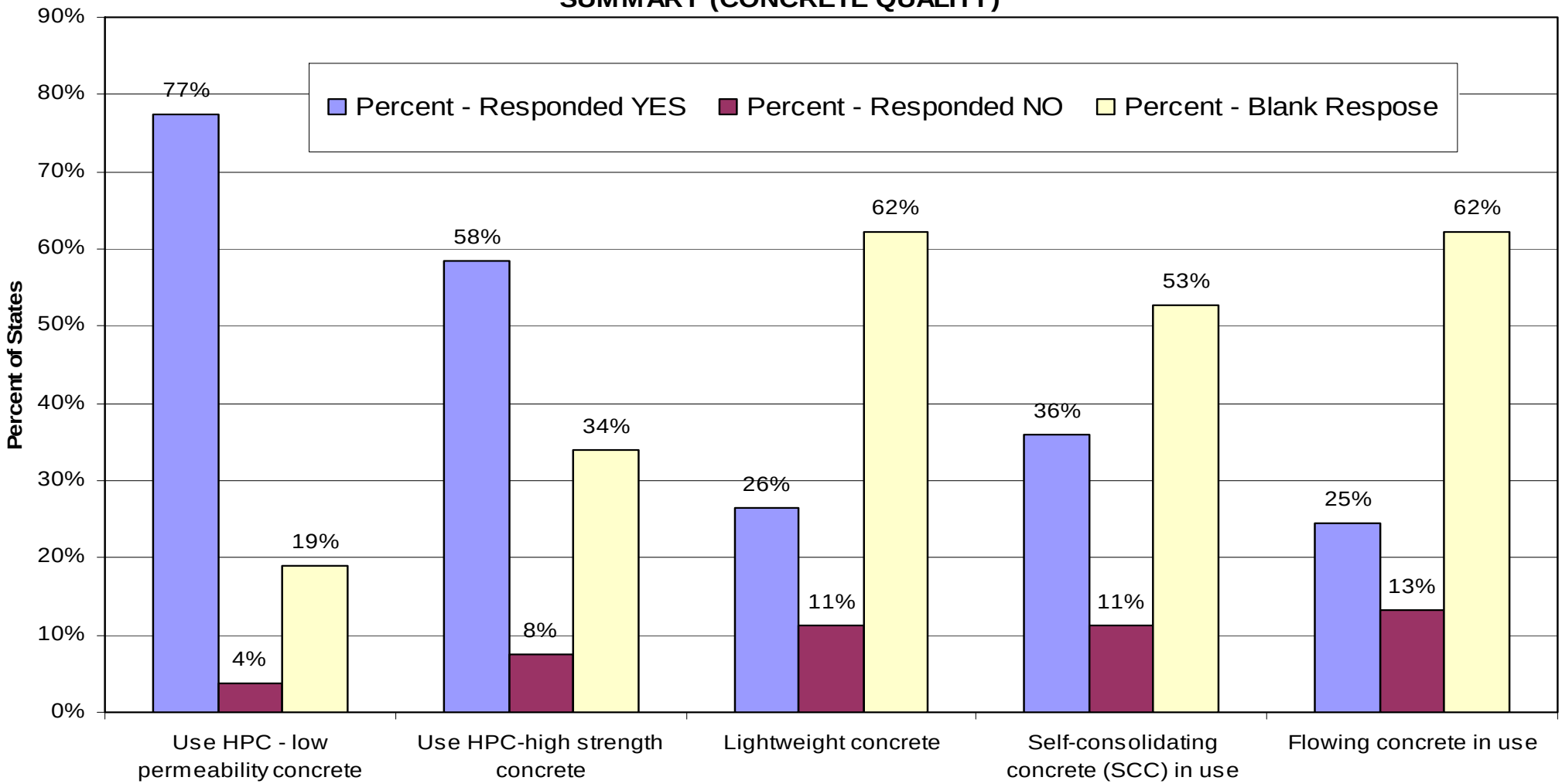
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 1	Changes Made in Last 10 Yrs	Included in Current Specs.
	% Responded YES	% Responded YES
Use HPC - low permeability concrete	77%	60%
Use HPC-high strength concrete	58%	47%
Allow admixtures	57%	79%
Concrete Strengths	74%	79%
Bridge Deck curing	75%	81%
Deck finishing requirements	47%	70%
Limit cement/alkali content	32%	57%
Testing and acceptance requirements	62%	83%
Heat of hydration required for cement	8%	13%

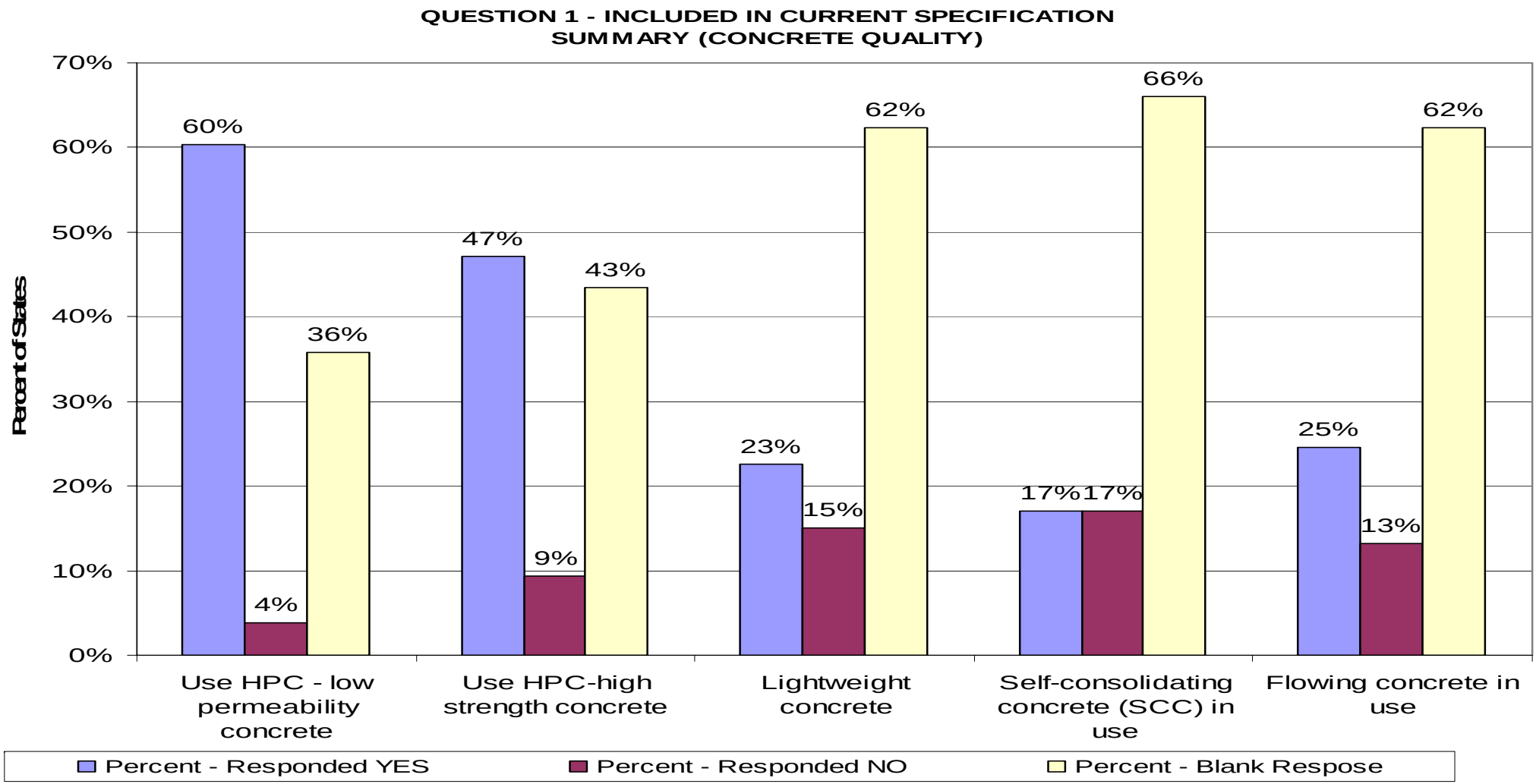
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 1	Changes Made in Last 10 Yrs	Included in Current Specs.
	% Responded YES	% Responded YES
Chloride testing of hardened concrete	28%	25%
Lightweight concrete	26%	23%
Self-consolidating concrete (SCC) in use	36%	17%
Flowing concrete in use	25%	25%
Epoxy coated reinf. steel used	34%	75%
Stainless Steel reinf. steel used	26%	6%
Stainless Clad reinf. steel used	21%	6%
Specify air void param. (spac. factor and/or specific surface)	4%	6%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

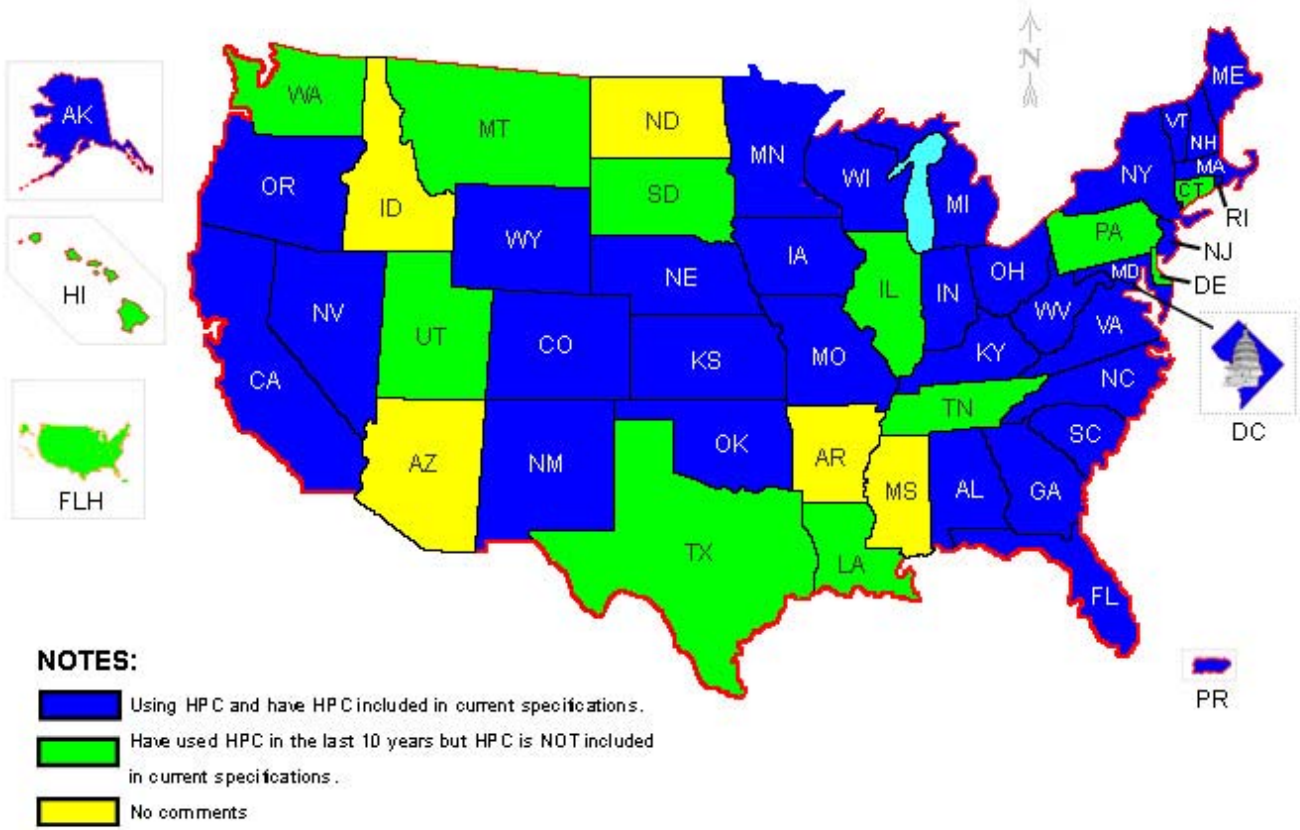


HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

STATES IMPLEMENTATION OF HIGH PERFORMANCE CONCRETE

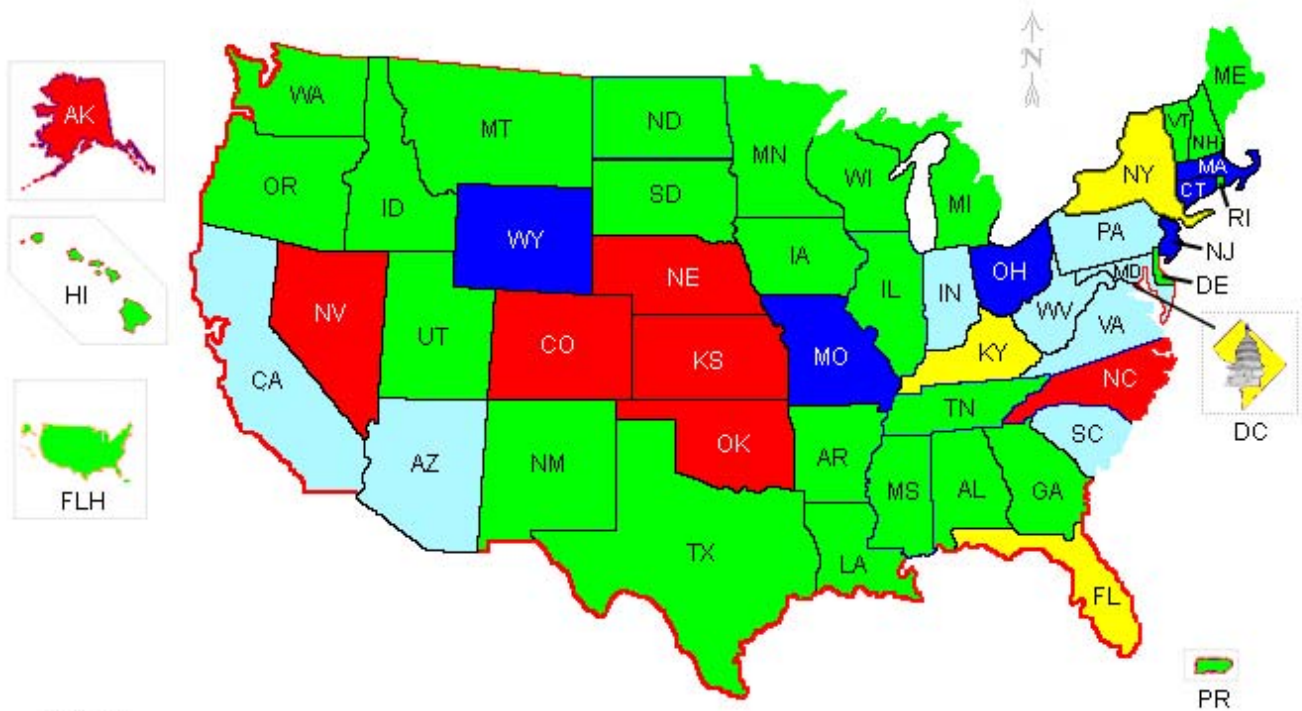


NOTES:

- Using HPC and have HPC included in current specifications.
- Have used HPC in the last 10 years but HPC is NOT included in current specifications.
- No comments

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

STATES USAGE OF LIGHTWEIGHT CONCRETE (LWC) IN THE LAST 10 YEARS AND INCLUSION IN SPECIFICATIONS

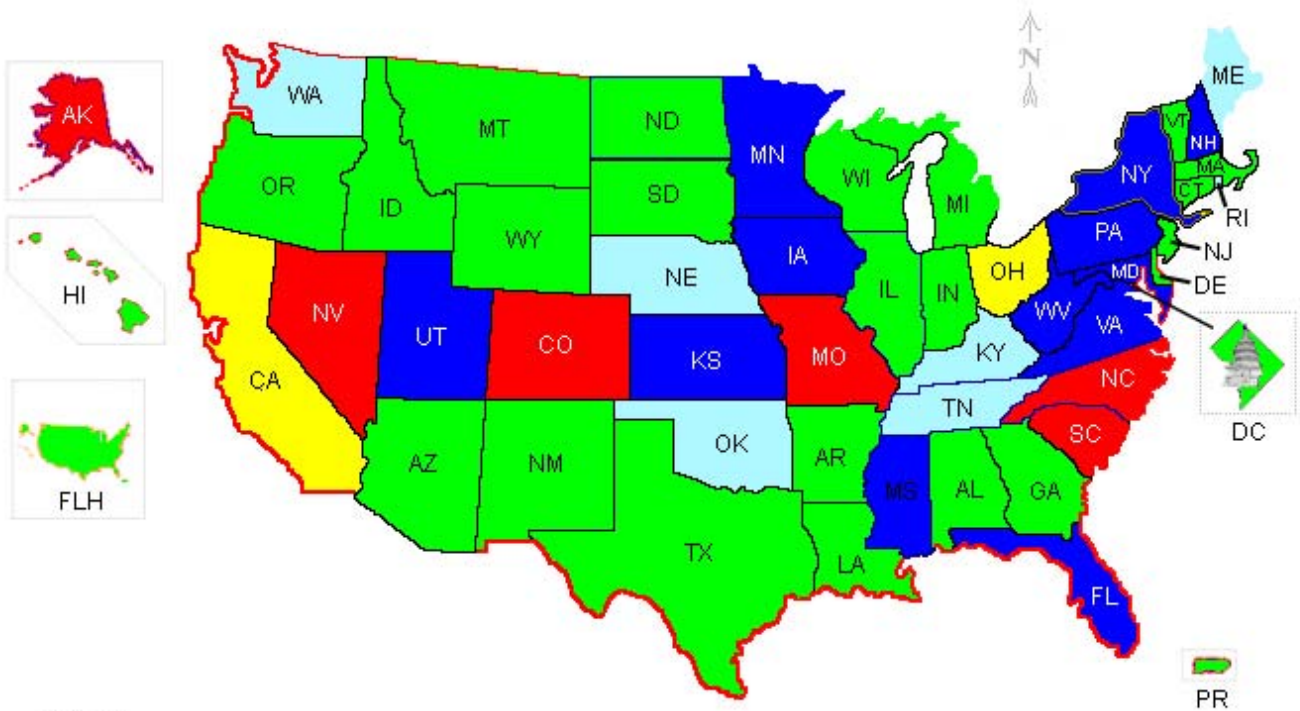


NOTES:

- LWC used in last 10 years
- LWC included in specifications
- LWC used in last 10 years and included in specifications
- LWC not used
- No comment

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

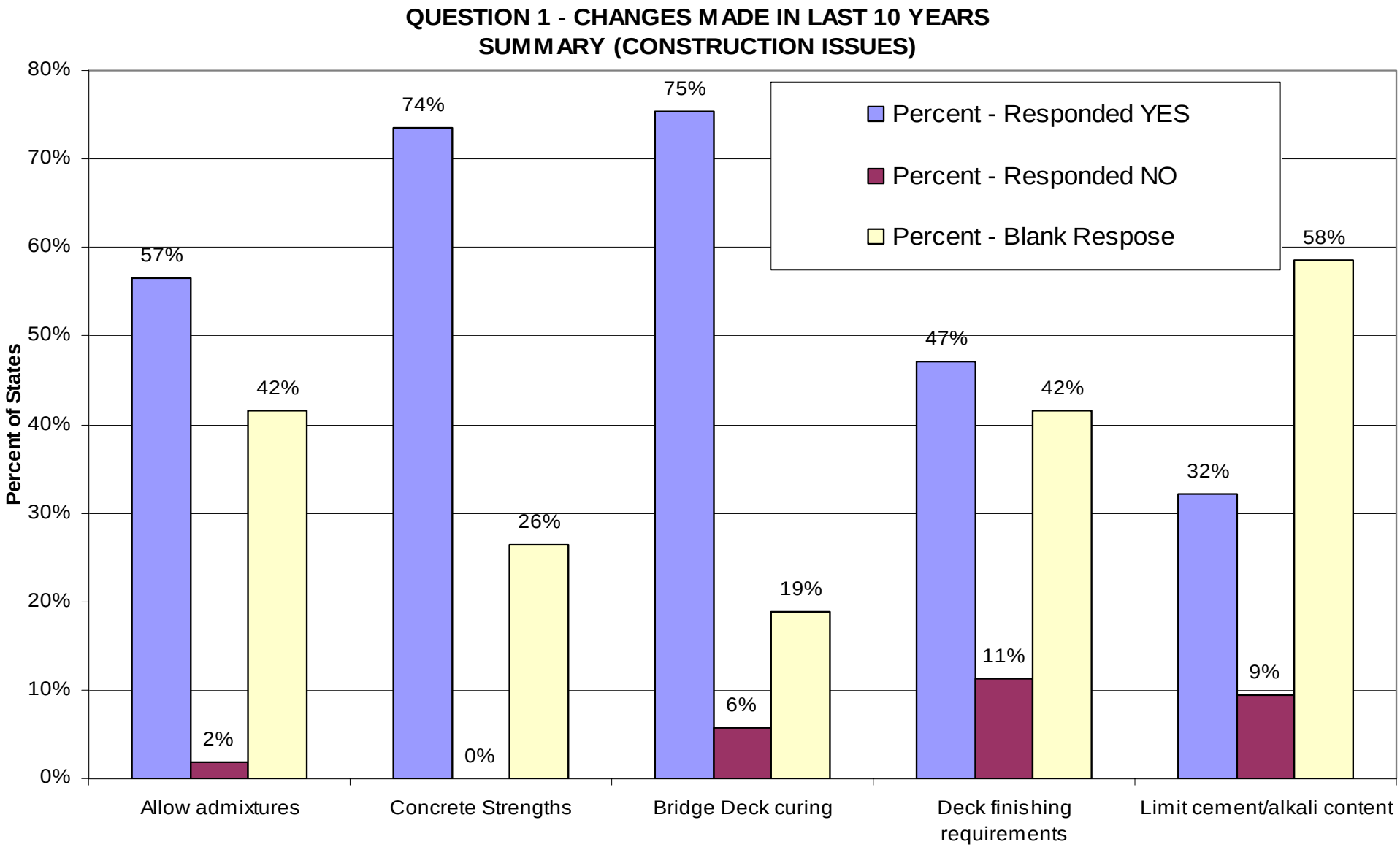
STATES USAGE OF SELF-CONSOLIDATING CONCRETE (SCC) IN THE LAST 10 YEARS AND INCLUSION IN SPECIFICATIONS



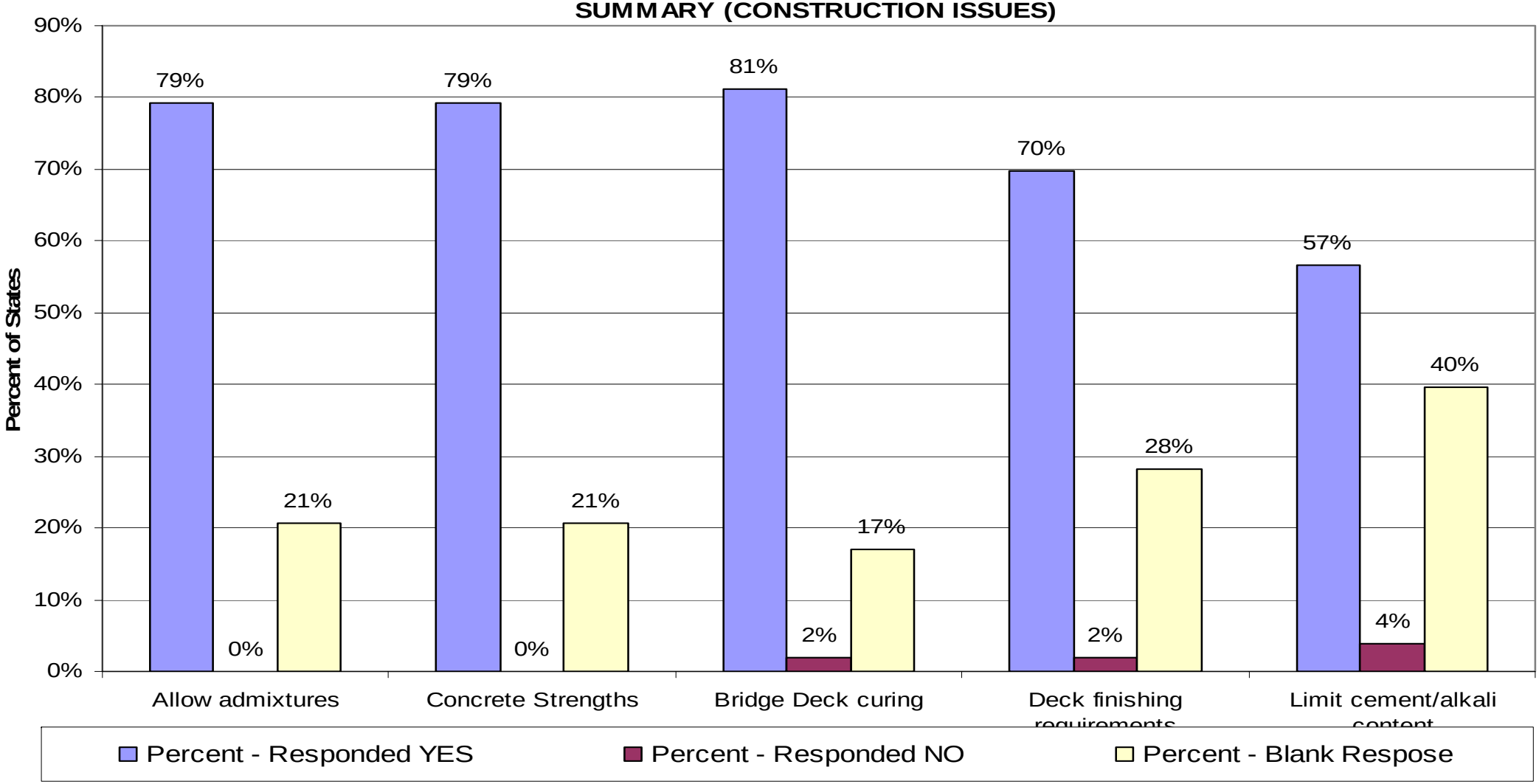
NOTES:

- SCC used in last 10 years
- SCC included in specifications
- SCC used in last 10 years and included in specifications
- SCC not used
- No comment

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



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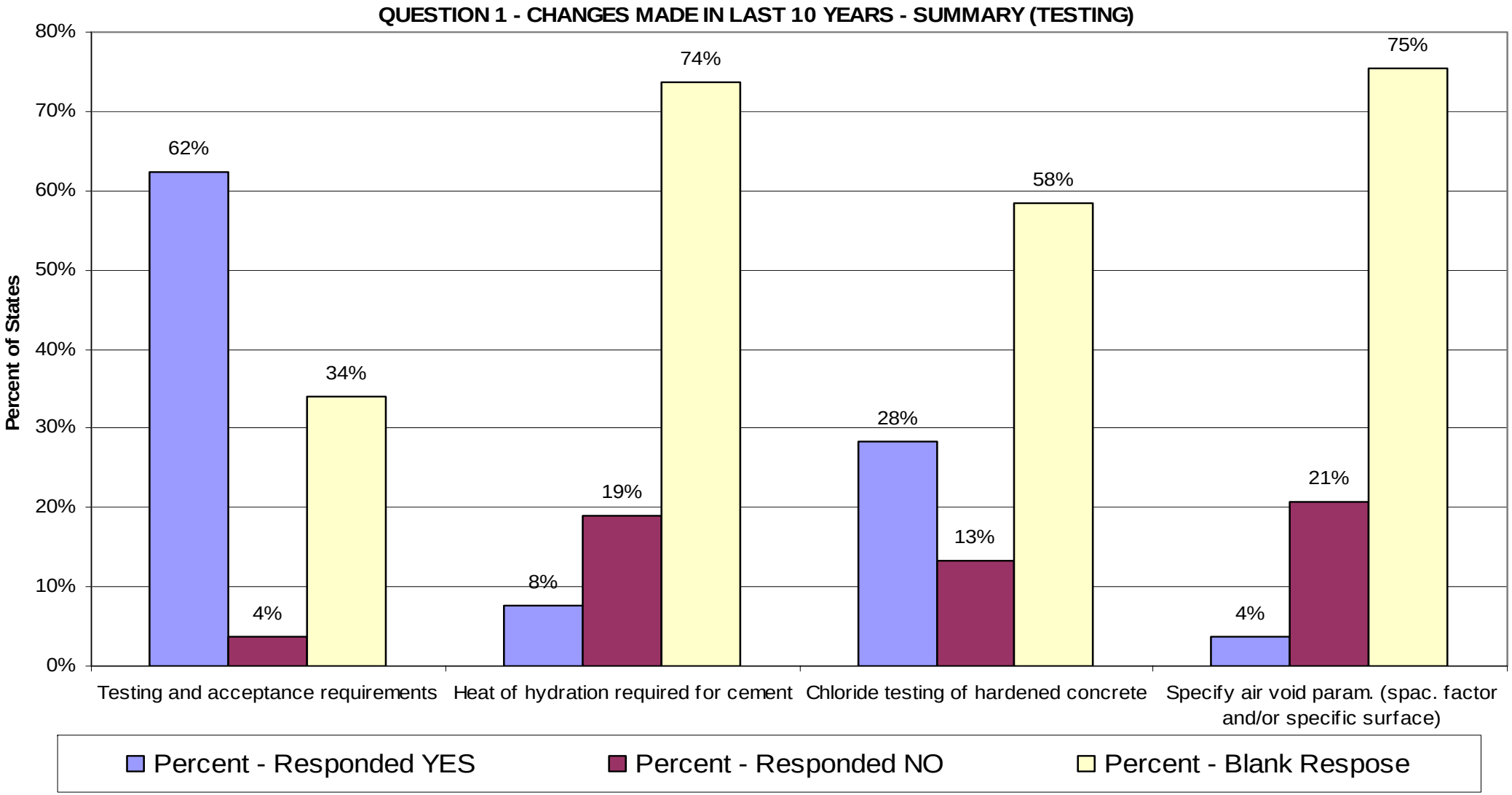

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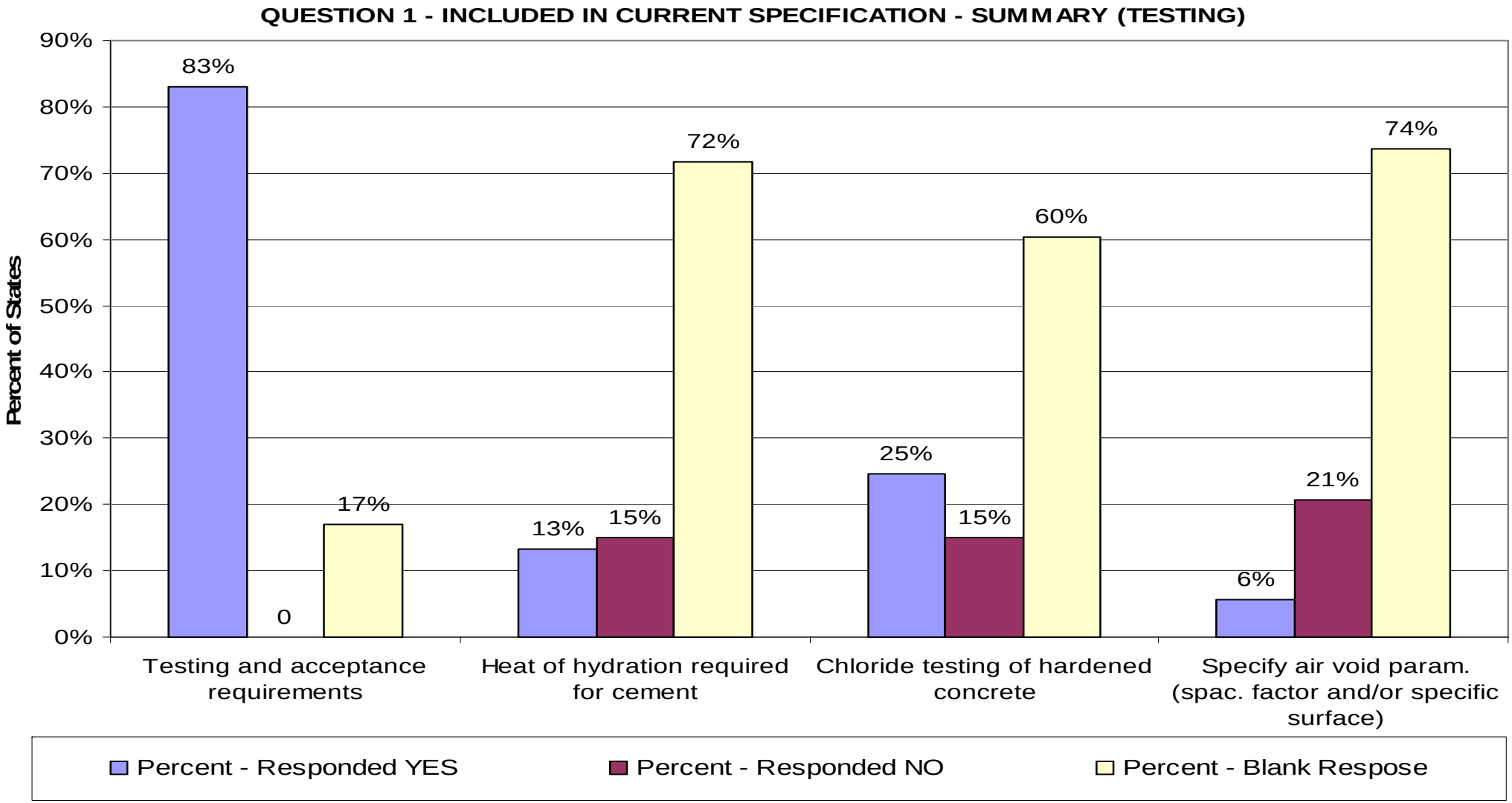
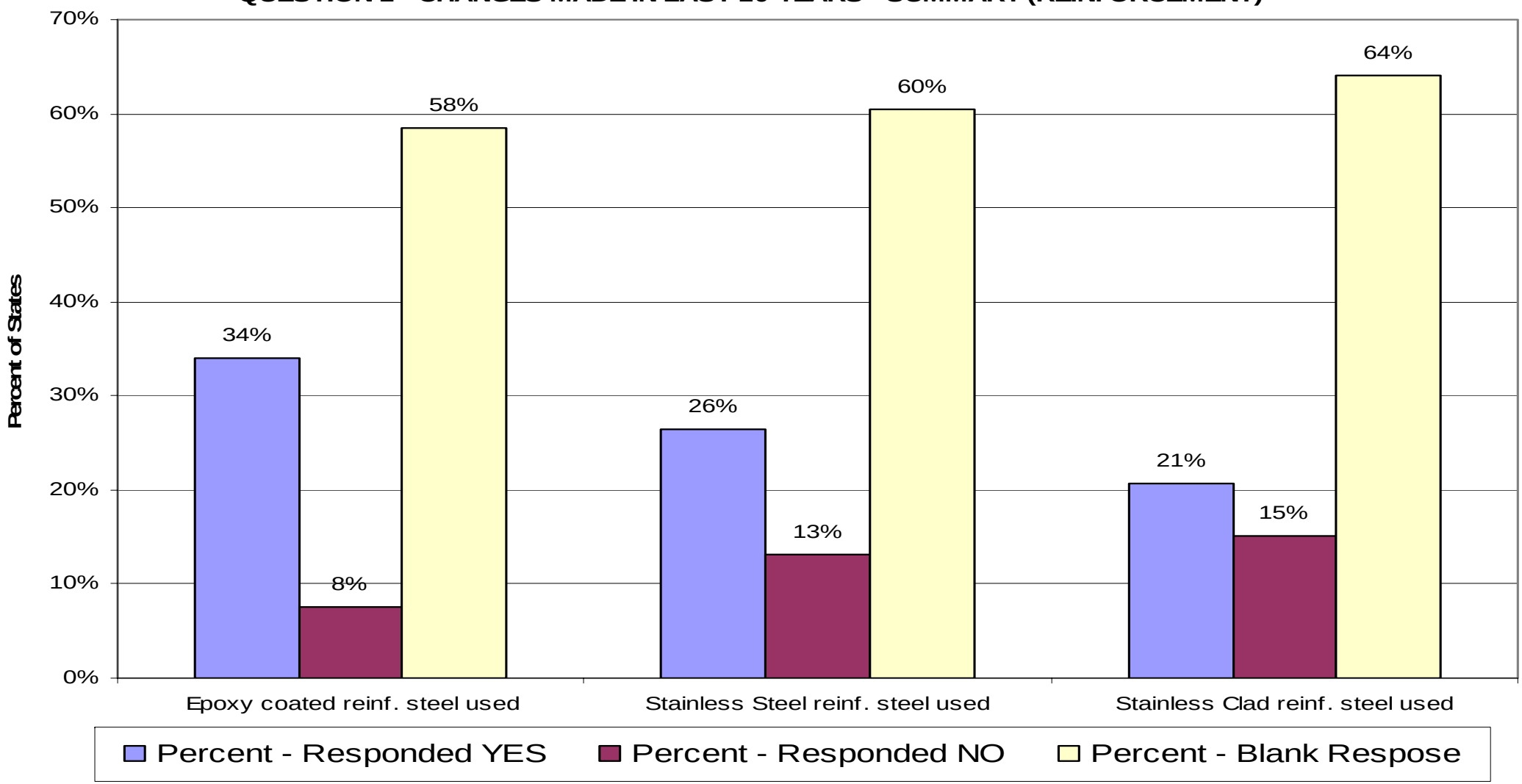
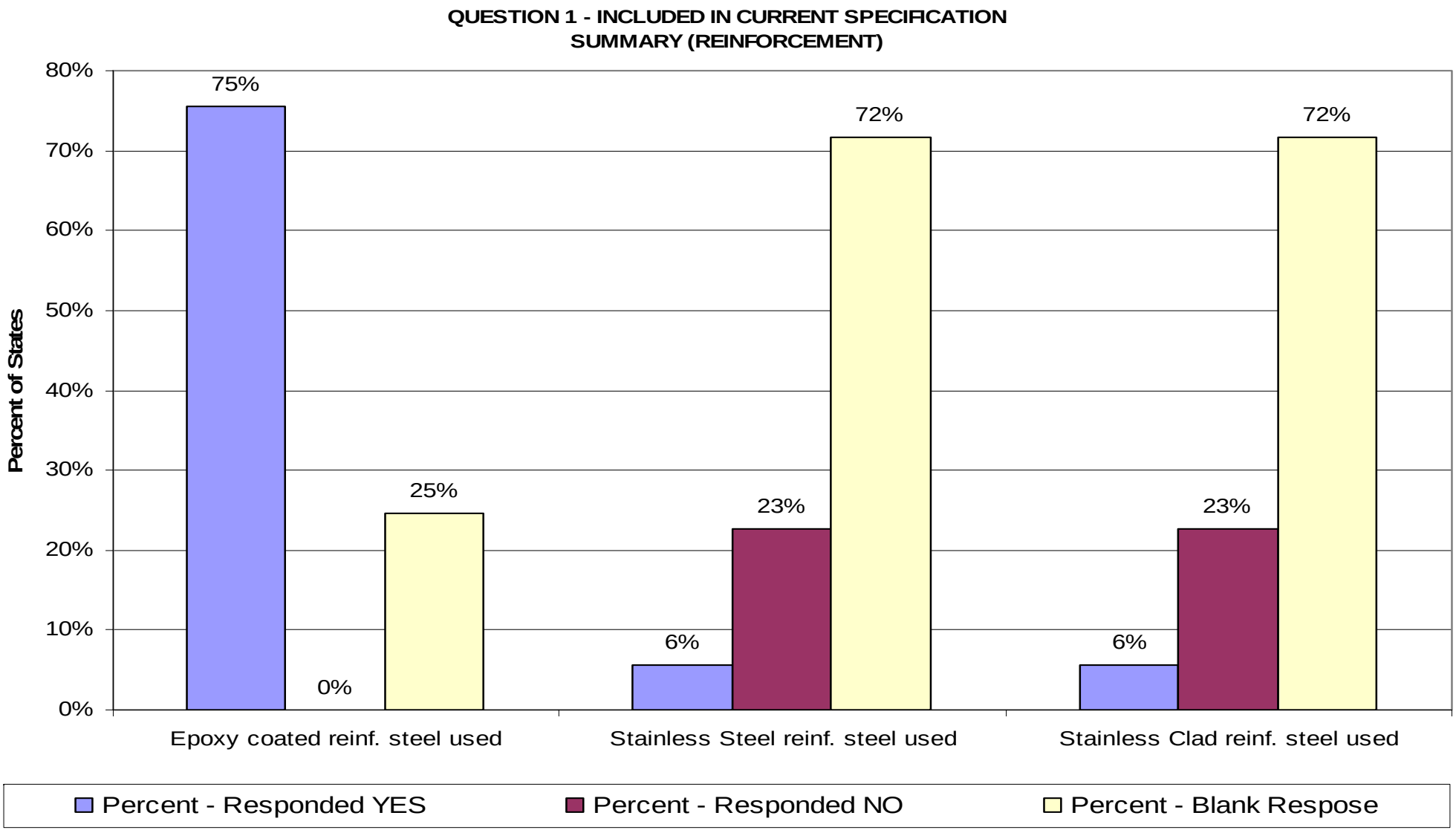


HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

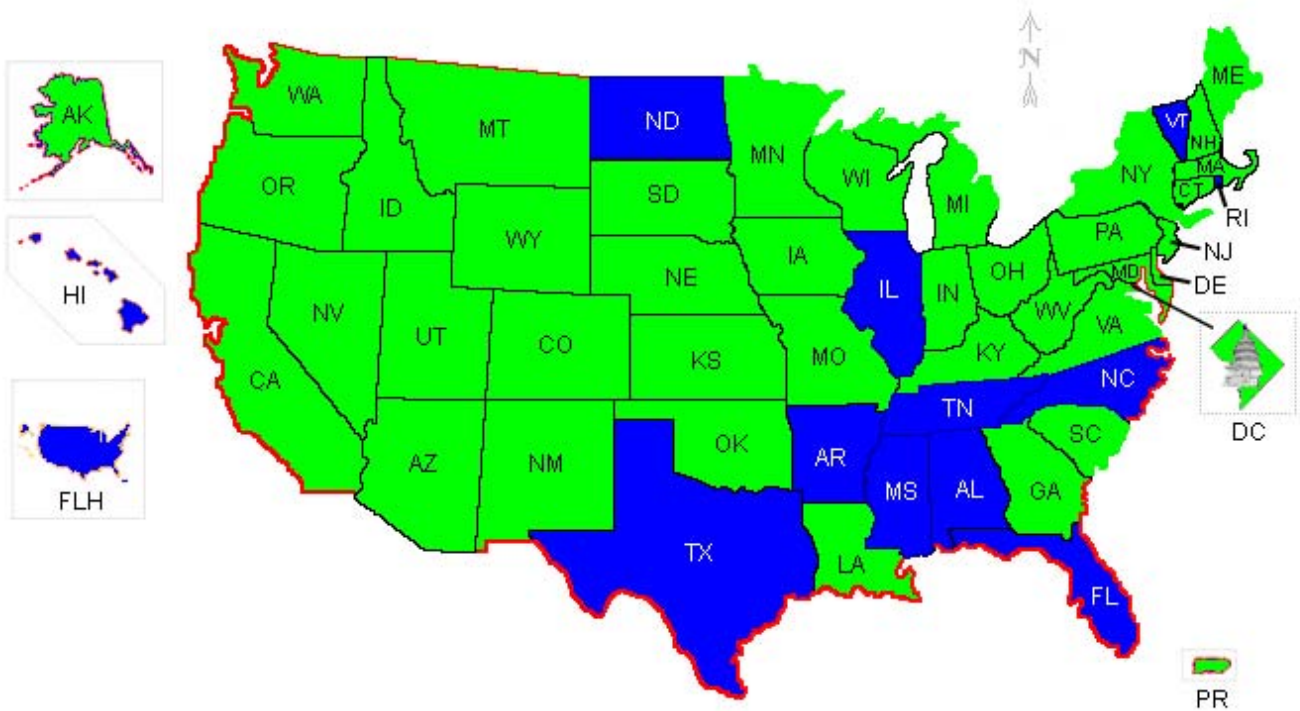


HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

STATES THAT INCLUDE EPOXY REINFORCEMENT IN THEIR SPECIFICATIONS

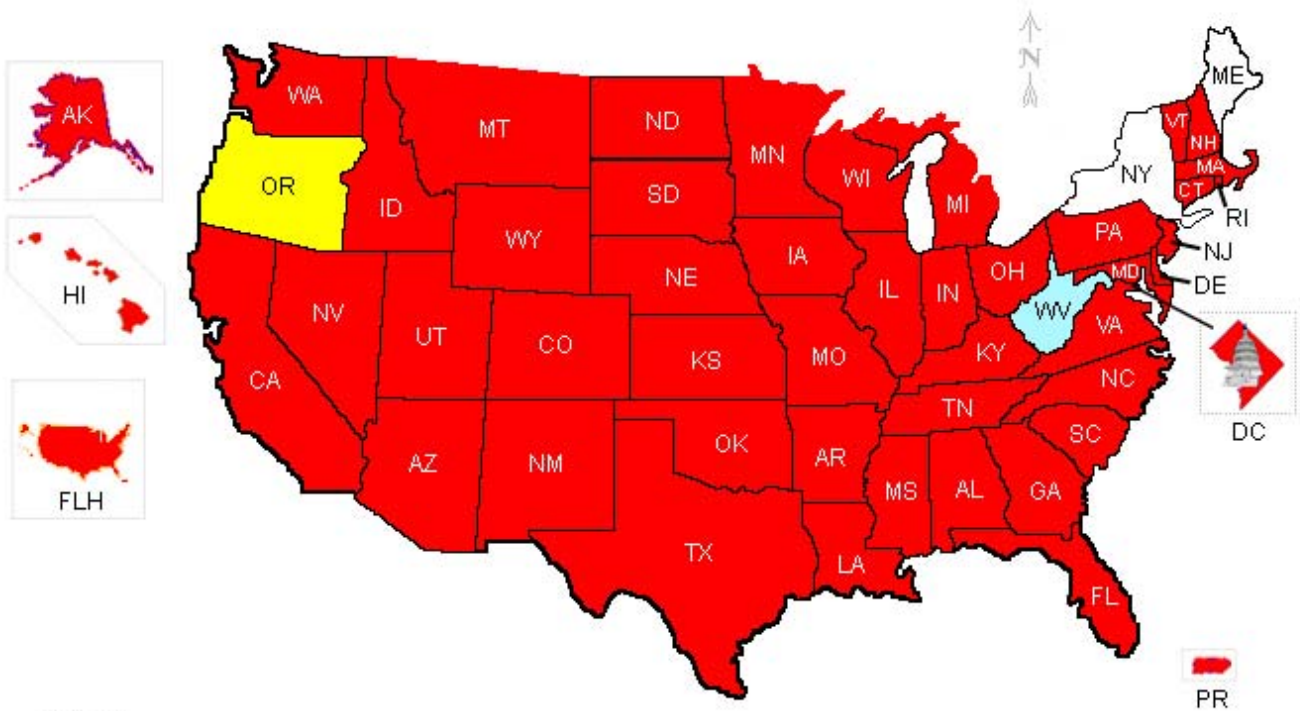


NOTES:

- Epoxy bars in specifications
- No comment and/or change

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

STATES INCLUSION OF STAINLESS STEEL (SS) AND SS CLADDED (SSC) IN SPECIFICATIONS



NOTES:

- Stainless Steel and Cladded Reinforcement
- SS Reinforcement only
- SSC Reinforcement only
- SS nor SSC reinforcement and/or No comment

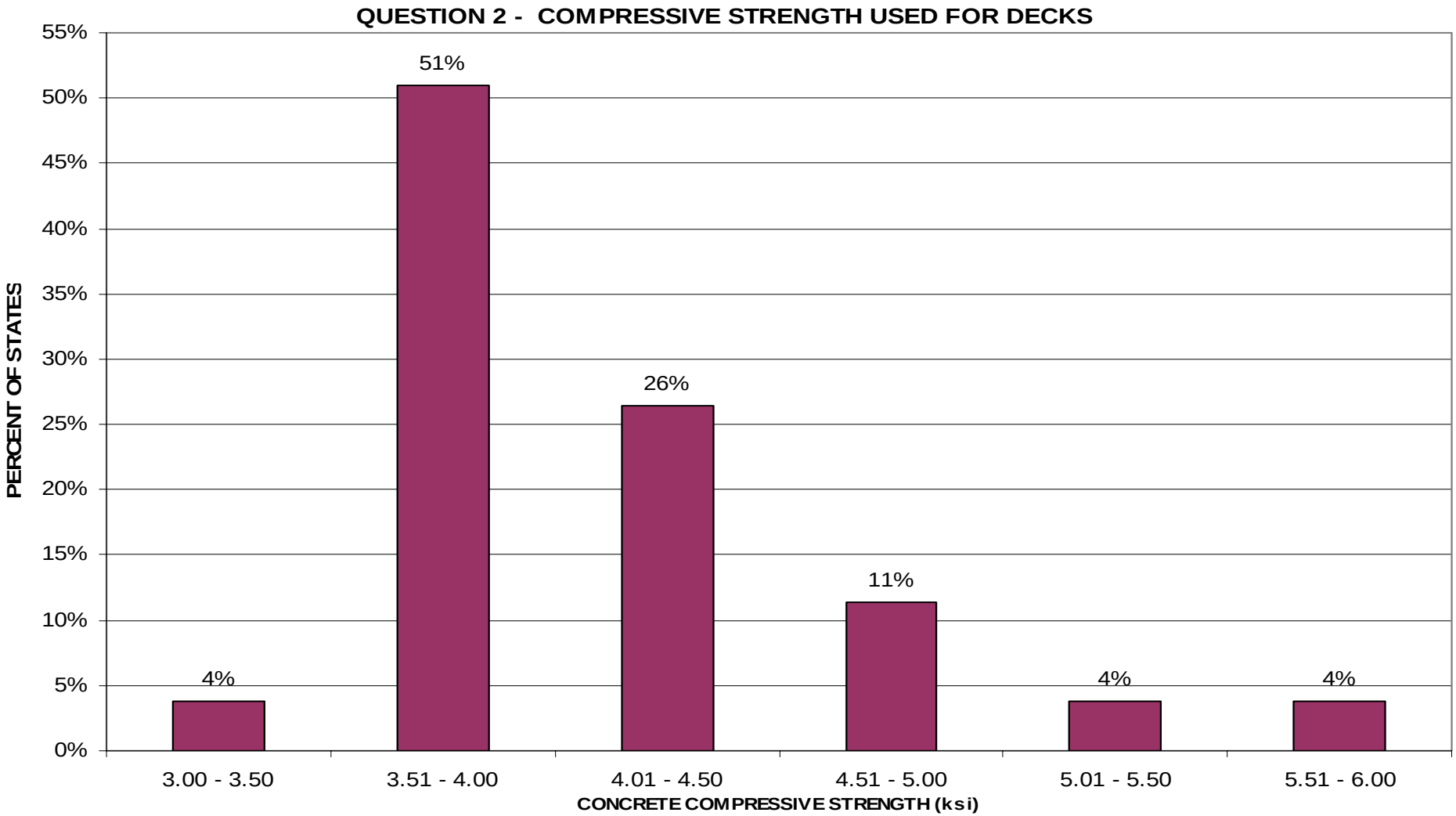
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 2 - Current Specification Summary/Ranges								
CLASS OF CONCRETE	**Air Content %**	**Air Content %**	**Max. W/C Ratio**	**Slump (in.)**	**Cement Type**	**Min. Cement Content (lb/cy)**	**Max. Cement Content (lb/cy)**	**Max. Aggreg. Size (in.)**
Prestressed	0 - 10%	0 - 10%	0.315 - 0.5	0 - 10	I, II, III and other types	400 - 840	550 - 893	0.5 - 1.5
Decks	1 - 10%	1 - 10%	0.35 - 0.52	0 - 9	I, II, III and other types	400 - 705	0 - 850	0.5 - 1.5
Parapets	1 - 10%	1 - 10%	0.35 - 0.53	0 - 9	I, II, III and other types	400 - 710	80 - 850	0.375 - 2
Substructure/ General	0 - 10%	0 - 10%	0.35 - 0.55	0 - 9	I, II, III and other types	400 - 705	0 - 850	0.5 - 2
Paving	1 - 10%	1 - 10%	0.4 - 0.559	0 - 9	I, II, III and other types	508 - 705	600 - 800	0.75 - 3
Latex Hydraulic Cement Concr.	0 - 10%	0 - 10%	0.22 - 0.4	2 - 9	I, II, III and other types	6.6 - 752	658 - 752	0.375 - 1.25
Silica Fume Concrete	1 - 9%	1 - 9%	0.33 - 0.42	2 - 8	I, II, III and other types	564 - 752	0 - 850	0.375 - 1.5

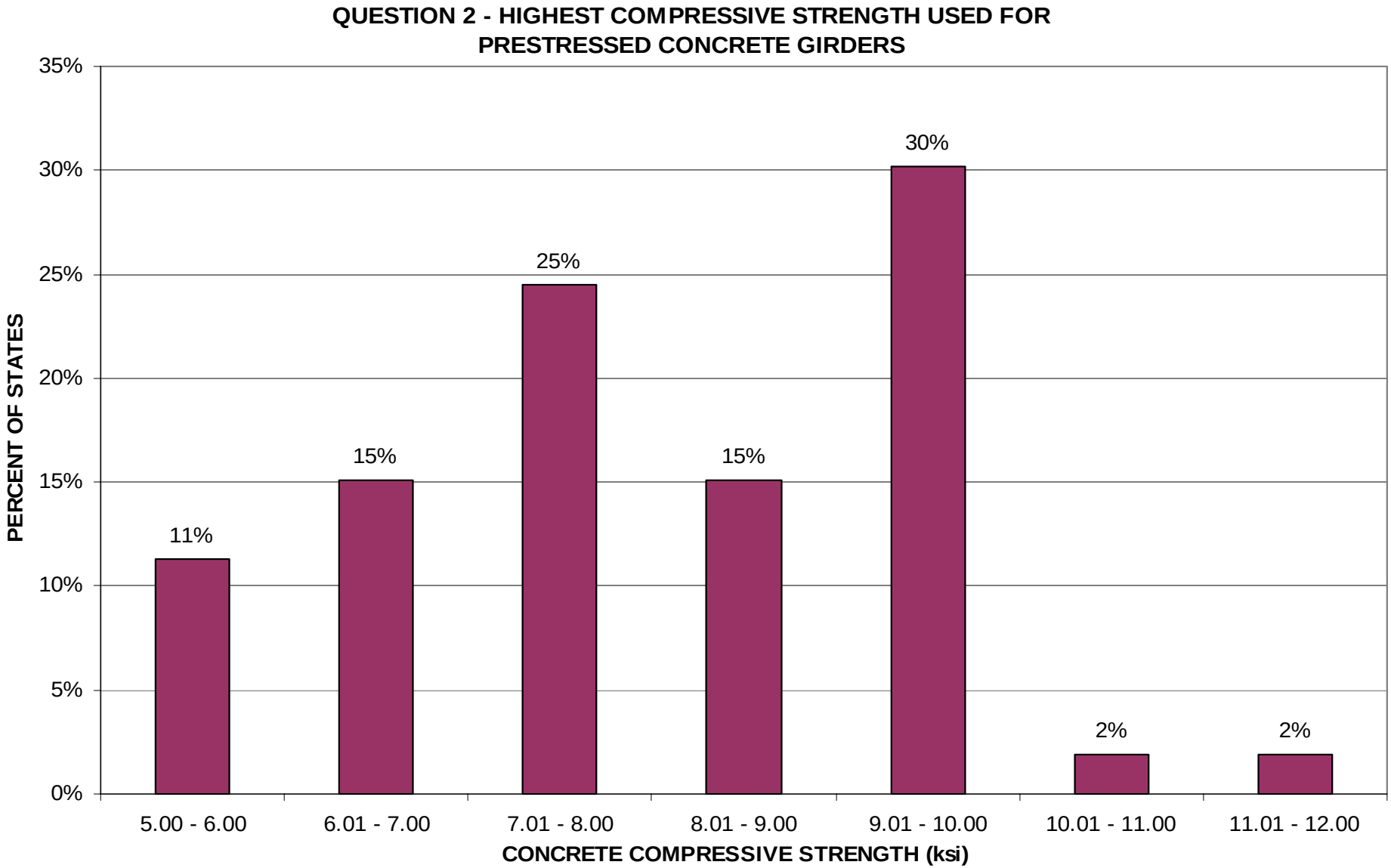
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 2 - Current Specification Summary/Ranges		
Highest Compr. strength used for prestr. concrete girders:	5 - 12	ksi
Compressive concrete strength used for decks:	3.1 - 6	ksi

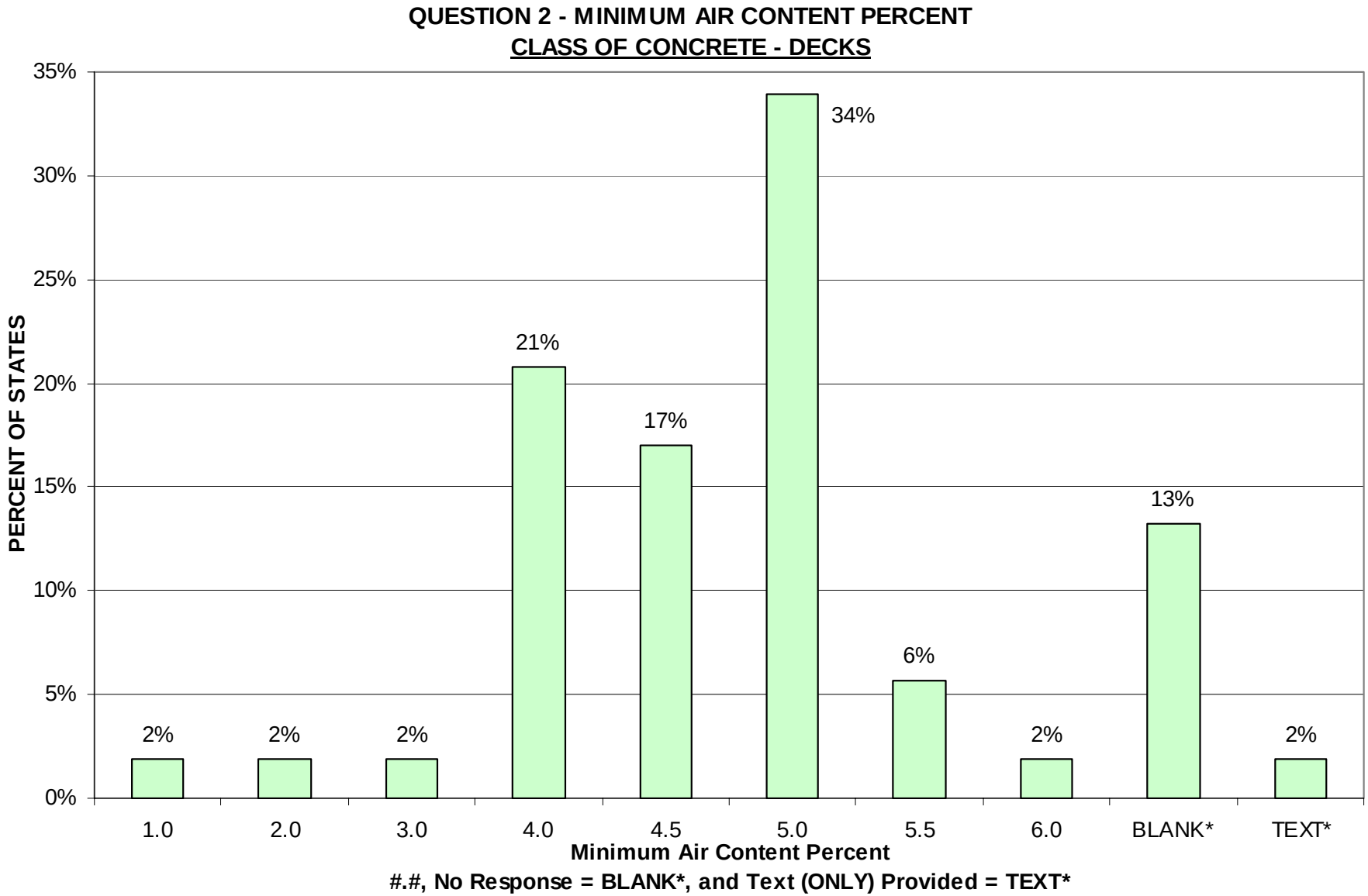
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



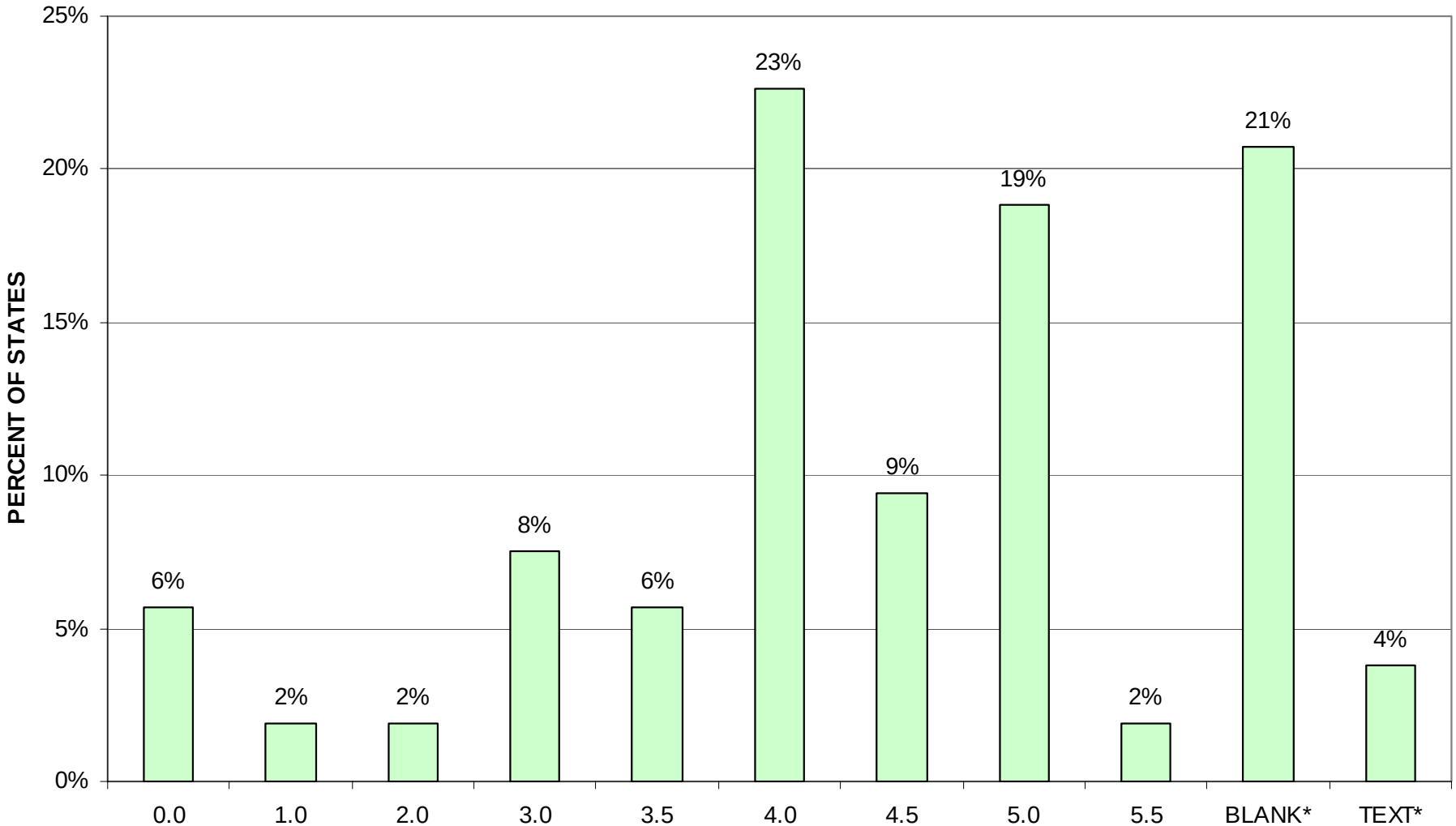
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 2 - MINIMUM AIR CONTENT PERCENT

CLASS OF CONCRETE - PRESTRESSED



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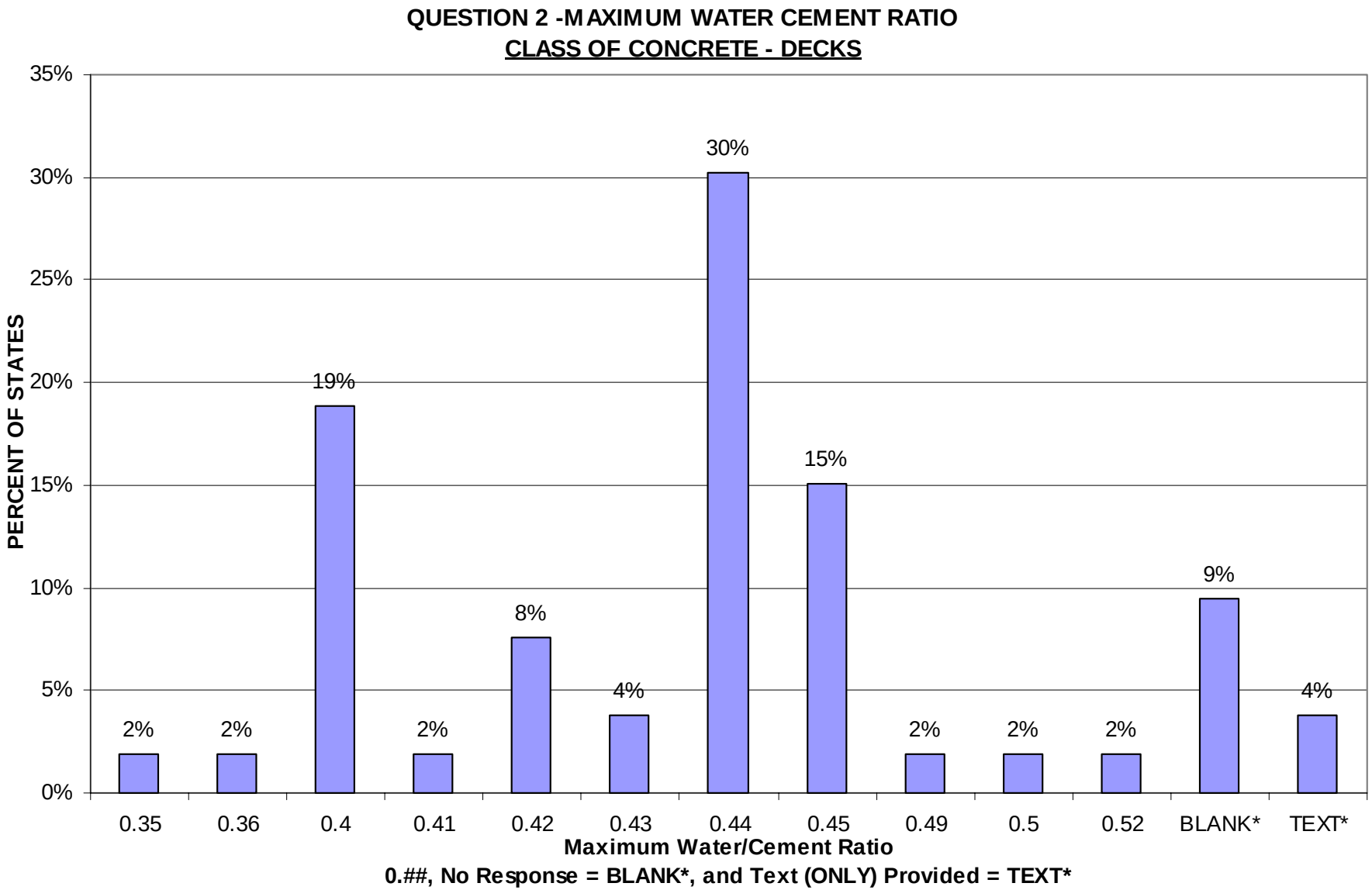
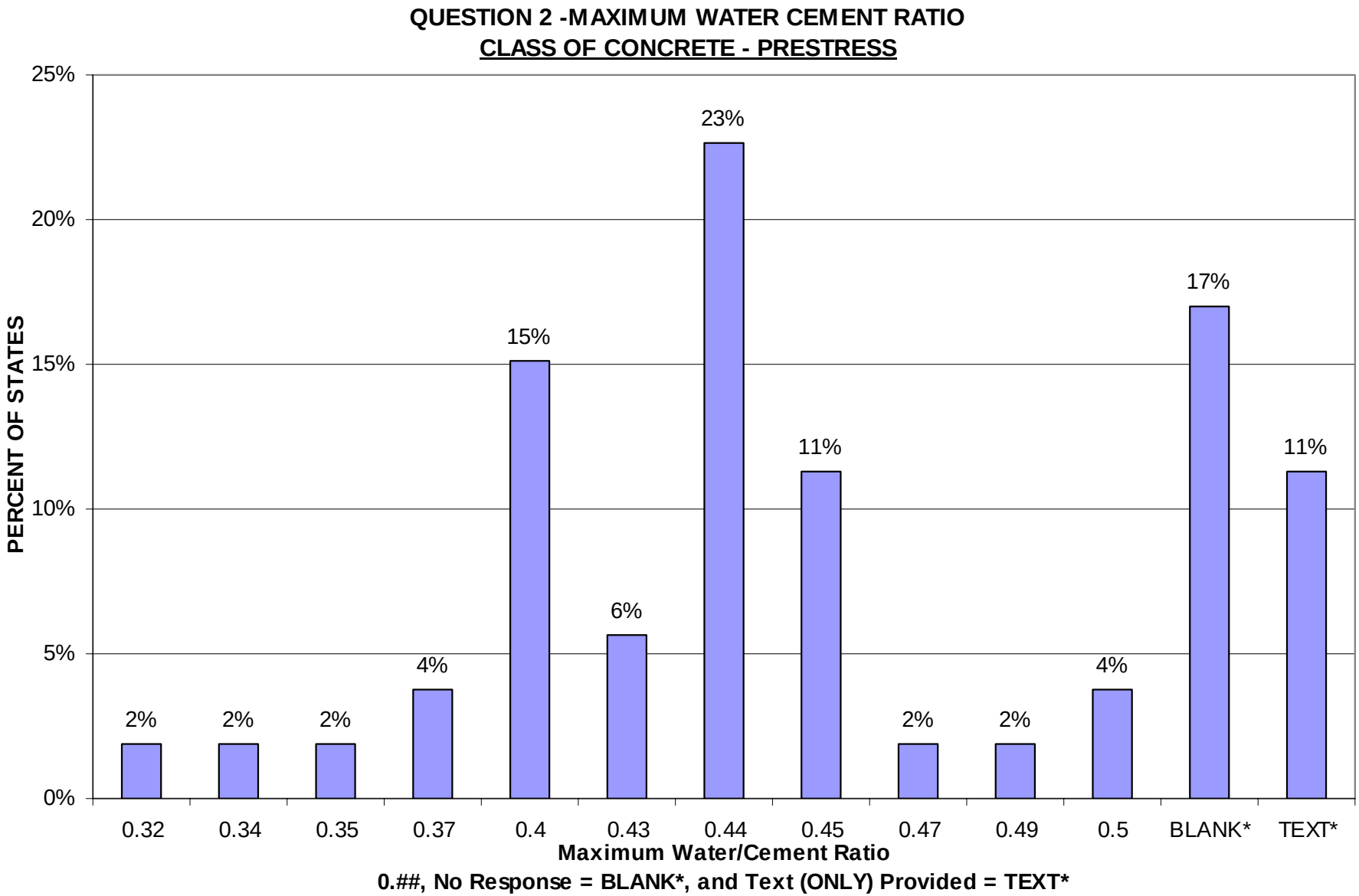
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



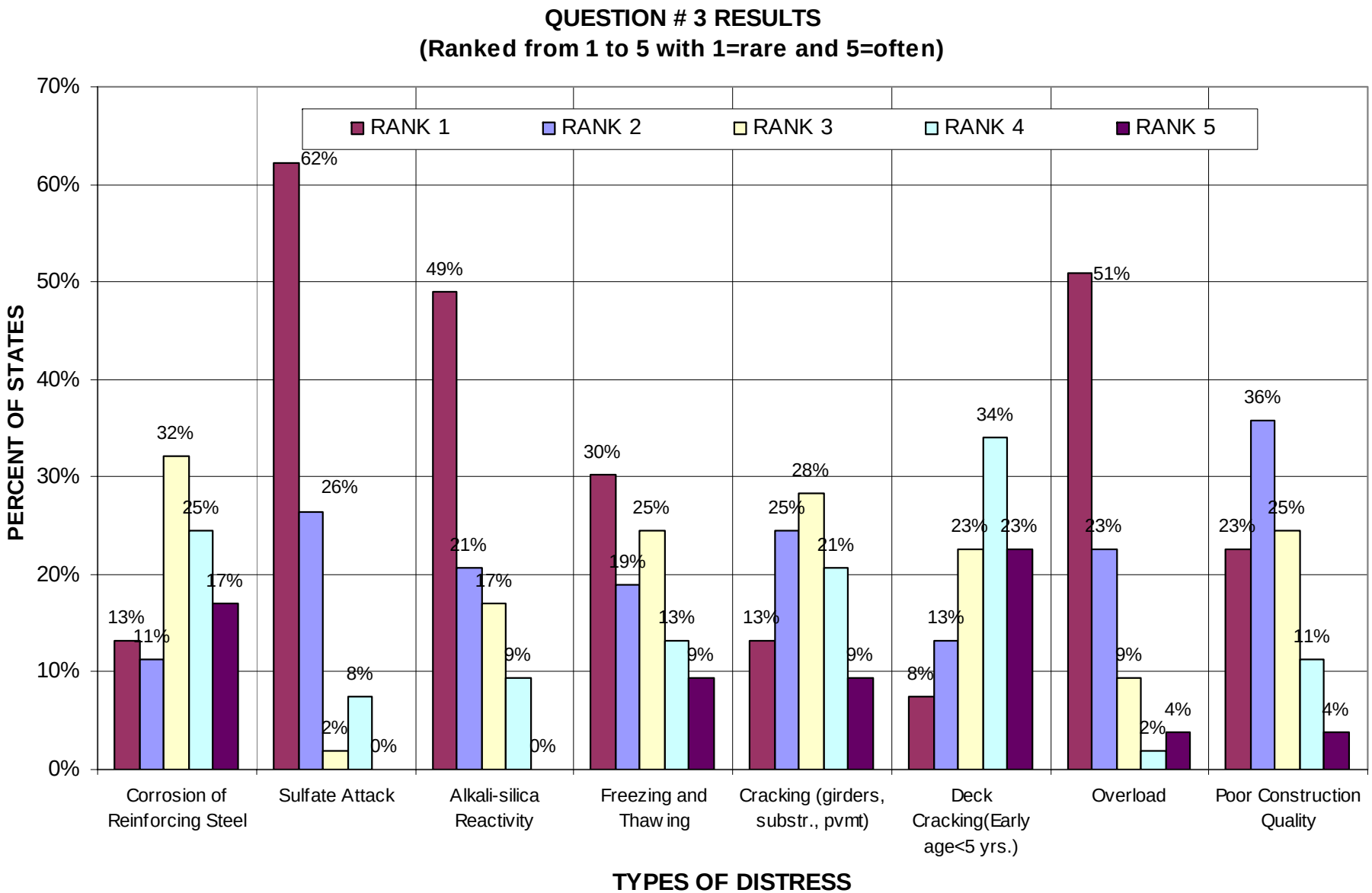
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 3 SUMMARY (NUMBER OF STATES)							
Type of Distress	**RANK**	**RANK**	**RANK**	**RANK**	**RANK**	**NO RANK**	**WEIGHTED SUM**
	1	**2**	**3**	**4**	**5**	**--**	
Corrosion of Reinforcing Steel	7	6	17	13	9	1	167
Sulfate Attack	33	14	1	4	0	1	80
Alkali-silica Reactivity	26	11	9	5	0	2	95
Freezing and Thawing	16	10	13	7	5	2	128
Cracking (girders, substr., pvmt)	7	13	15	11	5	2	147
Deck Cracking(Early age<5 yrs.)	4	7	12	18	12	0	186
Overload	27	12	5	1	2	6	80
Poor Construction Quality	12	19	13	6	2	1	123

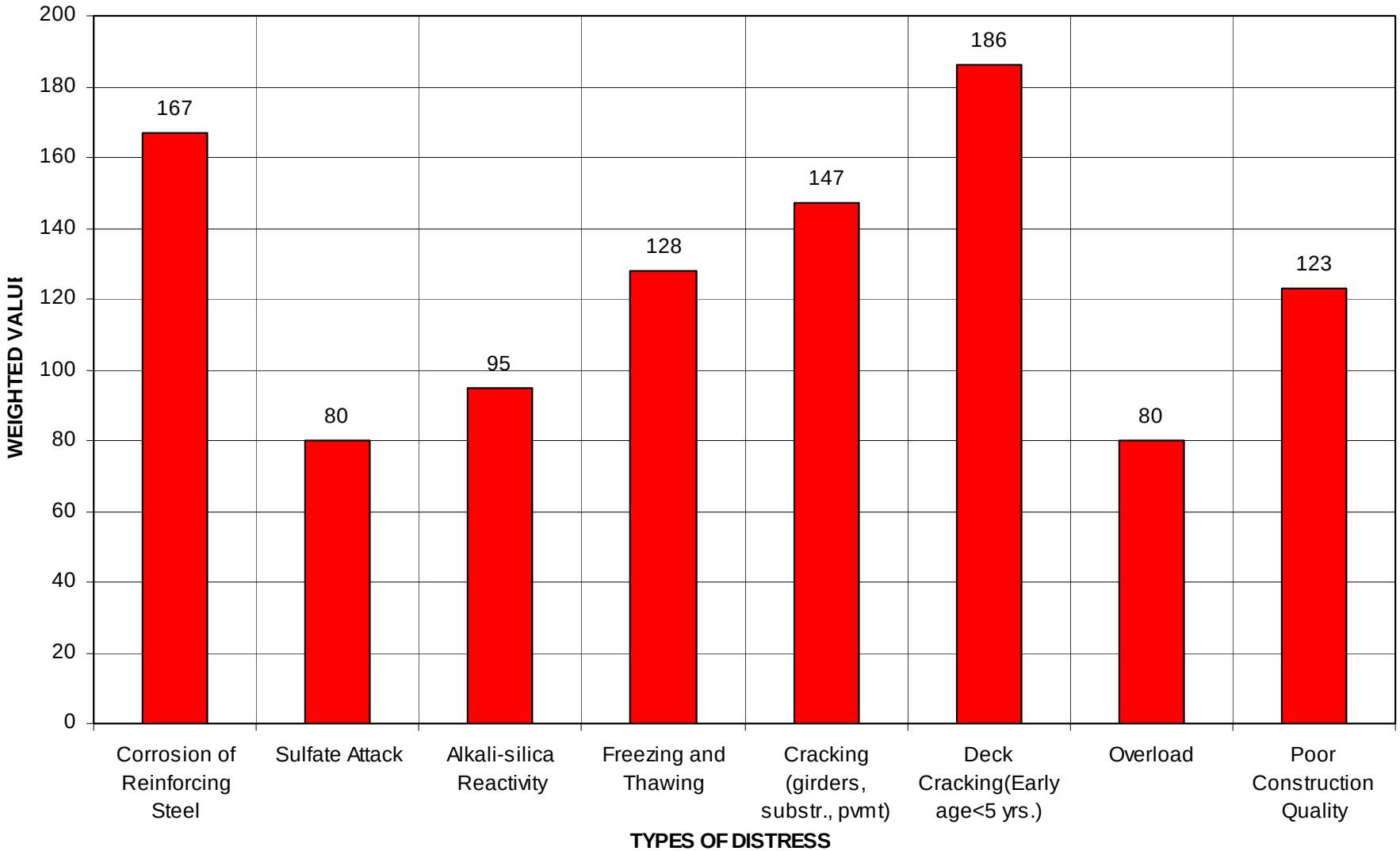
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 3 SUMMARY (PERCENT OF STATES)							
Type of Distress	RANK	RANK	RANK	RANK	RANK	NO RANK	WEIGHTED SUM
	1	2	3	4	5	--	
Corrosion of Reinforcing Steel	13%	11%	32%	25%	17%	2%	167
Sulfate Attack	62%	26%	2%	8%	0%	2%	80
Alkali-silica Reactivity	49%	21%	17%	9%	0%	4%	95
Freezing and Thawing	30%	19%	25%	13%	9%	4%	128
Cracking (girders, substr., pvmt)	13%	25%	28%	21%	9%	4%	147
Deck Cracking(Early age<5 yrs.)	8%	13%	23%	34%	23%	0%	186
Overload	51%	23%	9%	2%	4%	11%	80
Poor Construction Quality	23%	36%	25%	11%	4%	2%	123

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 4 - Part 1 & 2	NON-AGGR. ENVIR. (Part 1)	AGGRESSIVE ENVIR. (Part 2)
	% of 53* States that responded <YES>	% of 53* States that responded <YES>
Air-Entraining	79%	92%
Retarding	68%	75%
Accelerating	42%	38%
Water Reducing (Normal)	75%	81%
Water Reducing (High Range)	77%	81%
Water Reducing & Retarder	64%	72%
Water Reducing & Accelerator	34%	32%
Viscosity Modifying Admixtures	15%	19%
Silica Fume	45%	70%
Fly Ash, Class F	70%	77%
Fly Ash, Class C	49%	57%
Fly Ash, Class N	8%	8%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 4 - Part 1 & 2	NON-AGGR. ENVIR. (Part 1)	AGGRESSIVE ENVIR. (Part 2)
	% of 53* States that responded <YES>	% of 53* States that responded <YES>
Metakaolin	8%	11%
Rice Hull Ash	4%	4%
Other Ash Materials	2%	2%
Bark Ash	2%	2%
Bottom Ash	0%	0%
Pet Coke Ash	2%	2%
Slag	57%	62%
Latex	26%	36%
Corrosion Inhibitors	25%	42%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 4 Part 3	ELEMENTS WHERE USED									
	Number of States									
ADMIXTURE/SLAG	**ALL**	**Deck**	**Girder**	**Pier**	**Footing**	**Concrete Pile**	**Drilled Shaft**	**Overlay**	**Blank**	**Other**
Air-Entraining	36	11	4	8	4	3	1	0	0	0
Retarding	30	13	6	6	4	5	6	0	0	0
Accelerating	18	3	6	5	3	3	2	1	1	1
Water Reducing (Normal)	35	7	3	5	1	2	1	0	8	1
Water Reducing (High Range)	23	11	15	12	5	10	7	0	6	4
Water Reducing & Retarder	26	11	7	6	4	6	4	0	12	2
Water Reducing & Accelerator	15	2	4	3	1	3	1	0	31	1
Viscosity Modifying Admixtures	4	1	6	2	1	2	1	0	38	2
Silica Fume	10	25	9	7	2	4	0	1	15	1
Fly Ash, Class F	28	9	6	7	3	5	1	0	10	3
Fly Ash, Class C	21	6	5	6	2	5	1	0	19	3
Fly Ash, Class N	4	2	2	1	1	1	0	0	43	1

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 4 Part 3	ELEMENTS WHERE USED									
	Number of States									
ADMIXTURE/SLAG	**ALL**	**Deck**	**Girder**	**Pier**	**Footing**	**Concrete Pile**	**Drilled Shaft**	**Overlay**	**Blank**	**Other**
Metakaolin	3	4	0	1	1	1	0	0	41	1
Rice Hull Ash	3	1	0	0	0	0	0	0	46	0
Other Ash Materials	2	0	1	0	0	0	0	0	48	0
Bark Ash	3	0	0	0	0	0	0	0	48	0
Bottom Ash	2	0	0	0	0	0	0	0	50	0
Pet Coke Ash	3	0	0	0	0	0	0	0	48	0
Slag	23	9	5	7	5	3	2	1	15	2
Latex	3	18	1	1	0	1	0	4	26	2
Corrosion Inhibitors	6	10	10	8	3	5	1	0	28	0

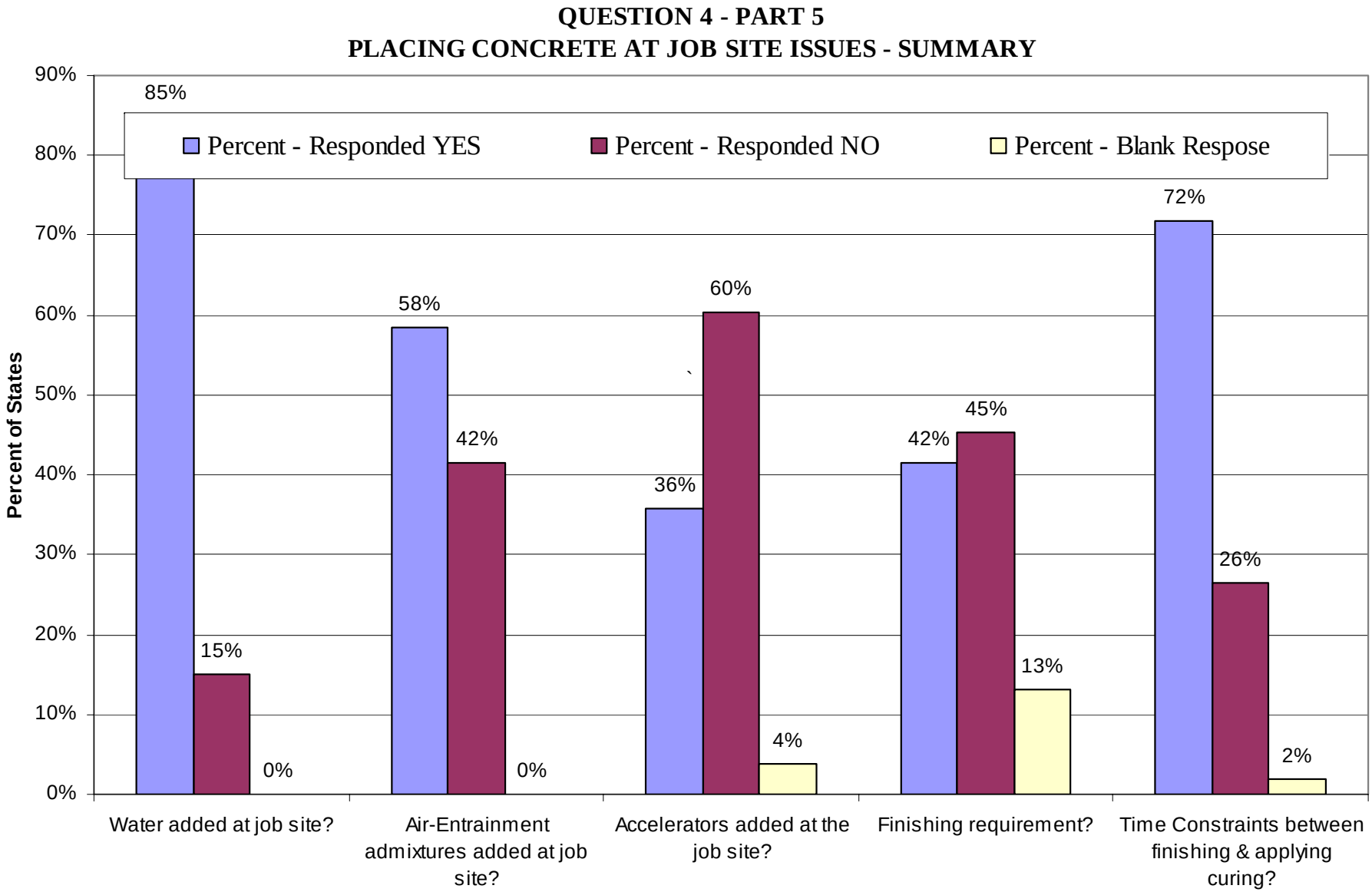
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 4 - Part 4	Range
Admixture Type and Slag	
Fly Ash	0 - 40%
Slag	0 - 75%
Silica Fume	0 - 15%
Metakaolin	0 - 20%
Rice Hull Ash	0 - 22%
Other Ash Material	0 - 30%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 4 - Part 5	% of 53* States that responded <YES>
Allowed Practice for Placing Concrete on Site	
Is water allowed to be added at the job site?	85%
Are air-entraining admixtures allowed to be added at the job site?	58%
Are accelerators added at the job site?	36%
Are there any special finishing requirements?	42%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

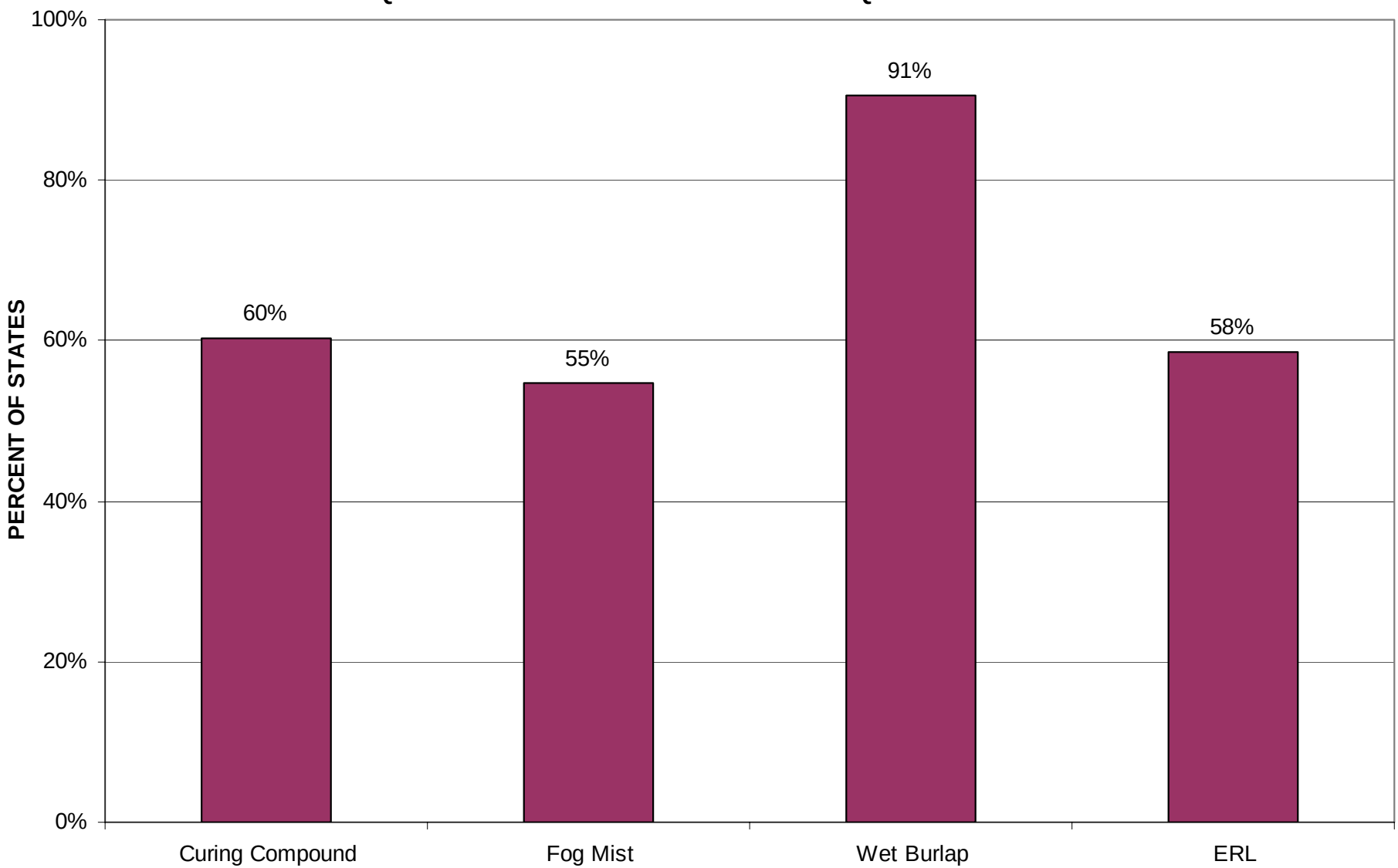


HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

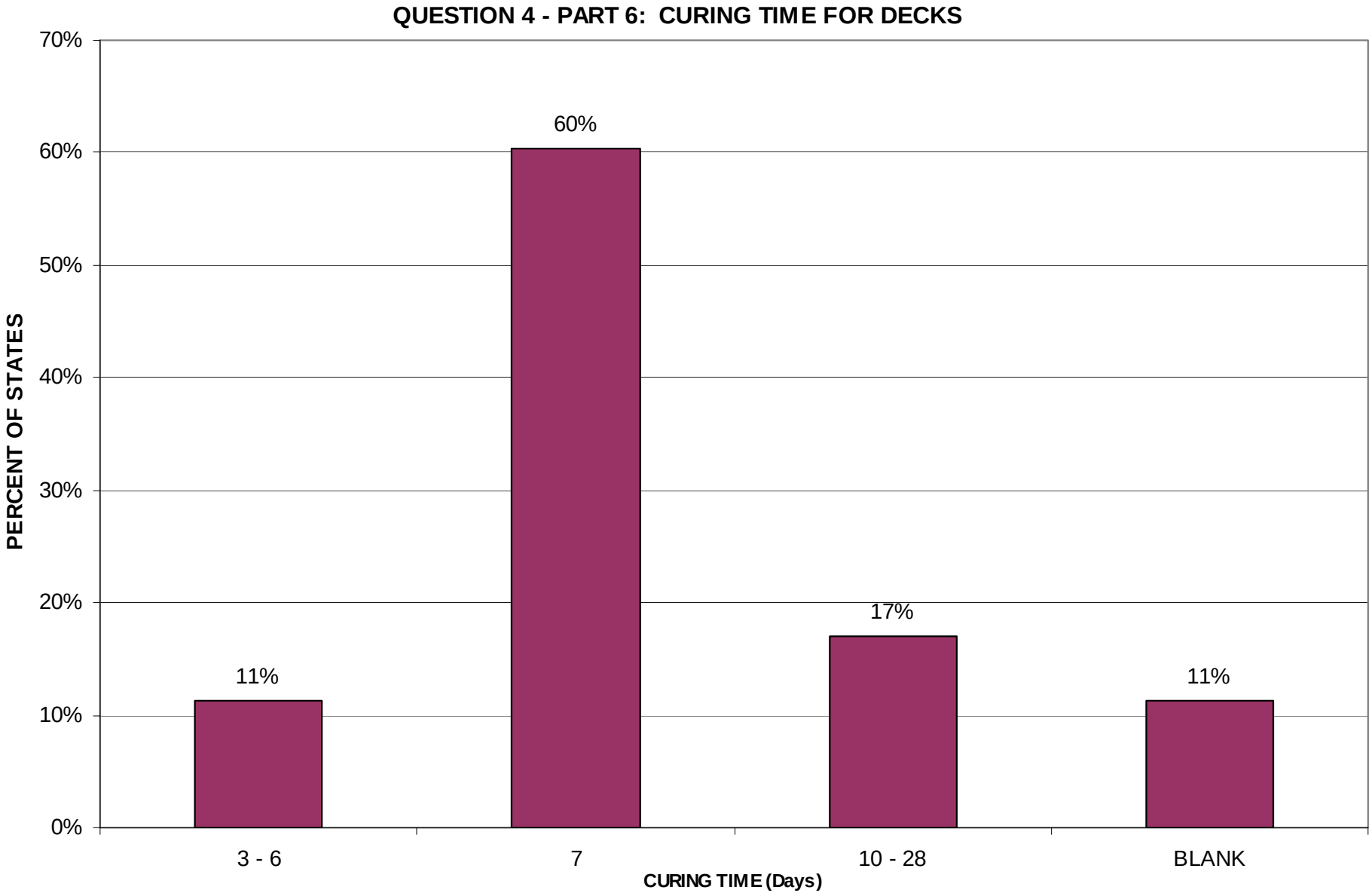
Question 4 - Part 6 - CURING REQUIREMENTS

Structural Element	Exist. Spec. <YES>	Curing Comp. <YES>	Fog Mist <YES>	Wet Burlap (days)	ERL LB/SF/HR	Cure Time (days)
Decks	89%	60%	55%	1 - 14	0 - 1	3 - 28
Silica Fume Overlay	47%	26%	43%	1 - 10	0.1 - 1	1 - 28
Latex Concrete Overlay	42%	11%	23%	0 - 7	0 - 0.15	1 - 7
Dense Concrete Overlay	34%	21%	13%	0 - 7	0.1 - 1	3 - 28
Paving	70%	70%	13%	0 - 7	0 - 0.2	0 - 14
Shotcrete	26%	25%	6%	0 - 7	0 - 0.1	0 - 7
Shotcrete with SF	15%	13%	6%	0 - 7	0 - 0.1	0 - 10
Massive Element	30%	15%	9%	0 - 14	0 - 0	3 - 28

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



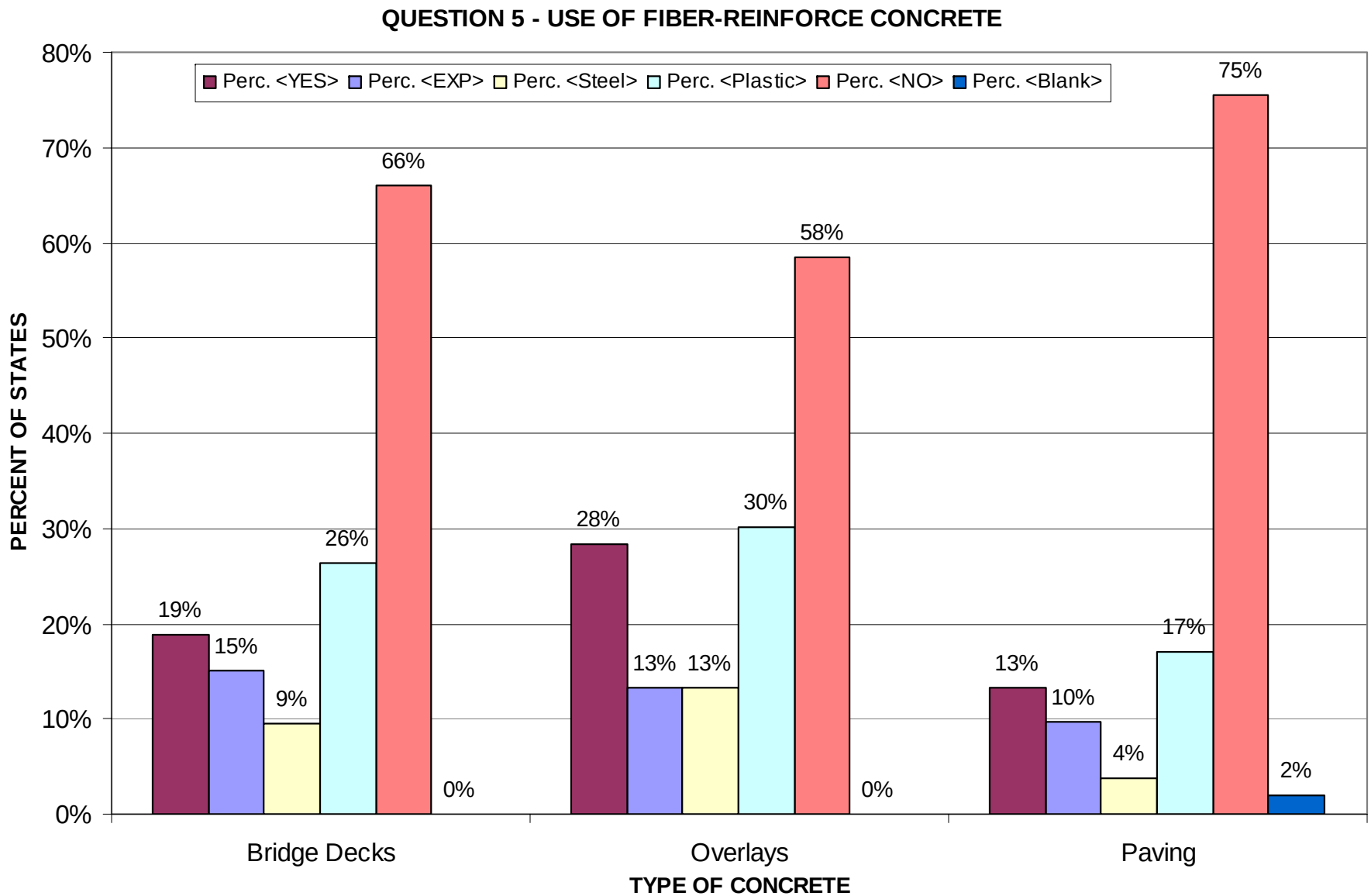
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 4 - Part 7: Evaporation Requirement	**% of 53* States that responded <YES>**
Any construction requirements for reducing evaporation?	64%
HOW?	4%
How often? (minutes)	0 - 180 min.

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 5		
	% of 53* States that responded <YES>	**% of 53* States that responded (EXP)**
Bridge decks: Fiber reinf. concrete specified?	19%	15%
Fiber Type: Steel	9%	
Fiber Type: Plastic	26%	
Overlays: Fiber reinf. concrete specified?	28%	13%
Fiber Type: Steel	13%	
Fiber Type: Plastic	30%	
Paving: Fiber reinf. concrete specified?	13%	10%
Fiber Type: Steel	4%	
Fiber Type: Plastic	0%	

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



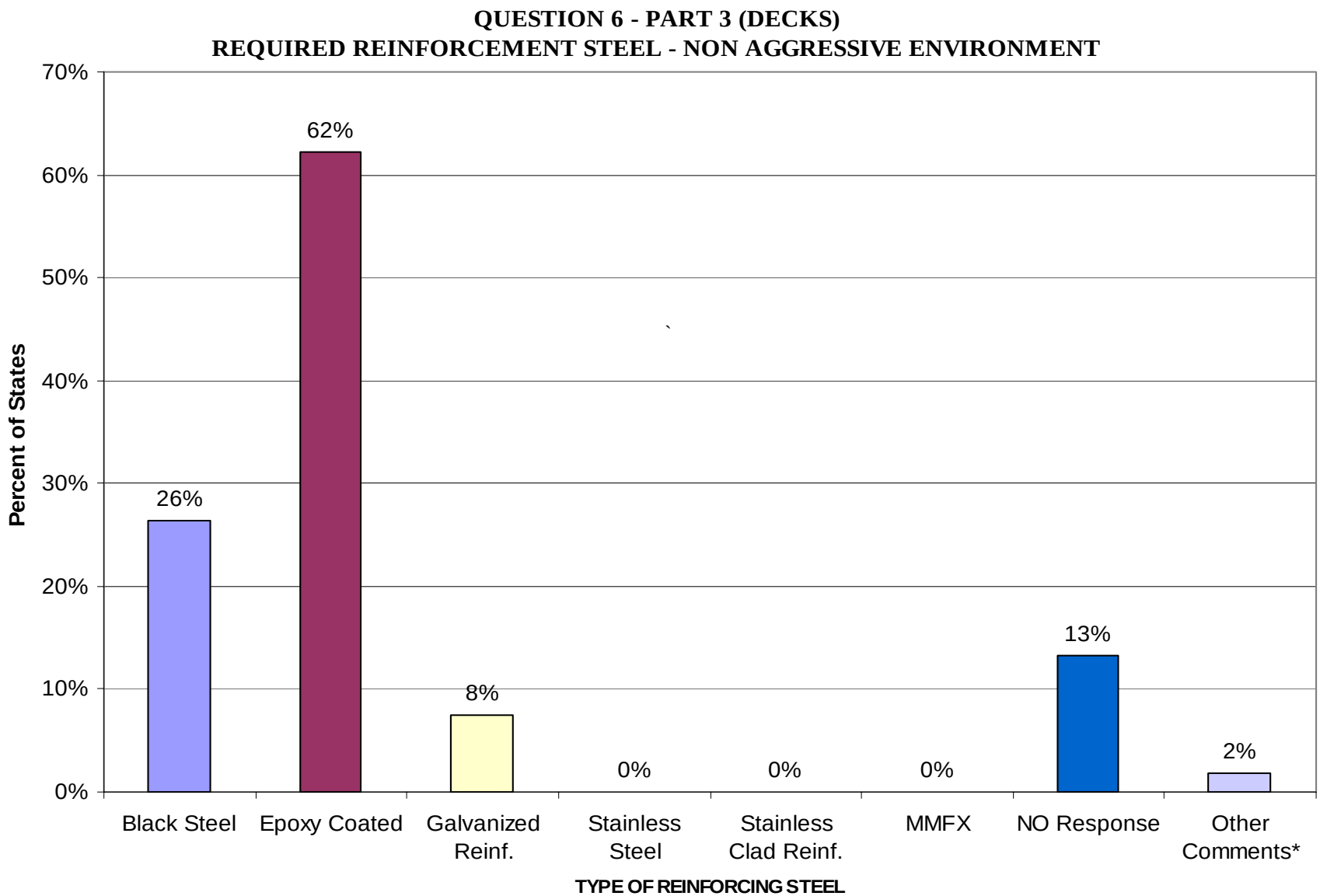
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 6 - MINIMUM COVER REQUIREMENTS		
STRUCTURAL ELEMENT	**COVER (inches)**	
	Part 1: Non-Aggressive Environment	**Part 2: Aggressive Environment**
Deck - Top	1.5 - 3	2 - 3
Deck - Bottom	1 - 3	1 - 3
Reinforced Concrete Beams	1 - 3	1 - 3
Prestr. Concr. Beams - CIP	1 - 3	1 - 3
Prestr. Concr. Beams - Precast	1 - 3	1 - 4
Substructure - Piers	1.5 - 5	1.5 - 6
Substructure - Abutments	1.5 - 3	1.5 - 4
Substructure - Footings	2 - 4	1.5 - 4
Substructure - Drilled Shaft	3 – 6	3 - 6

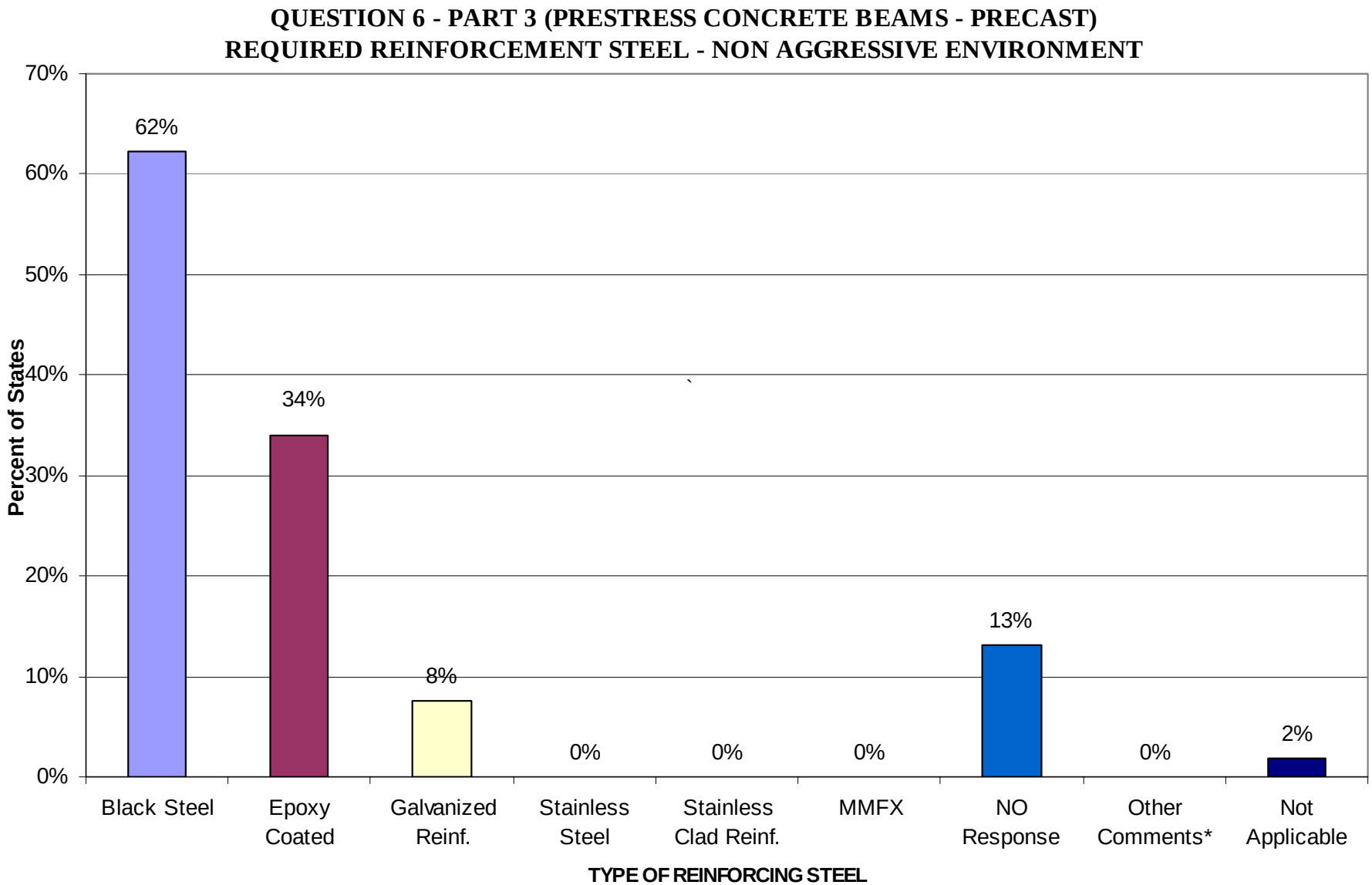
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 6 - REQUIRED REINFORCING STEEL									
STRUCTURAL ELEMENT	TYPE REINFORCING STEEL Part 3 - Non-Aggressive Environment								
	BS	ECS	GS	SS	SCD	MMFX	No Response	Other Comments*	Not Used
Decks – Top	26%	62%	8%	0%	0%	0%	13%	2%	0%
Decks – Bottom	34%	53%	8%	0%	0%	0%	13%	0%	2%
Reinforced Concrete Beams	45%	25%	4%	0%	0%	0%	26%	0%	8%
Prestressed Concrete Beams, CIP	38%	23%	4%	0%	0%	0%	32%	0%	11%
Prestressed Concrete Beams, Precast	62%	34%	8%	0%	0%	0%	13%	0%	2%
Substructure – Piers	66%	28%	9%	0%	0%	0%	9%	0%	2%
Substructure – Abutments	68%	28%	8%	0%	0%	0%	9%	0%	2%
Substructure - Footings	70%	21%	8%	0%	0%	0%	9%	0%	2%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



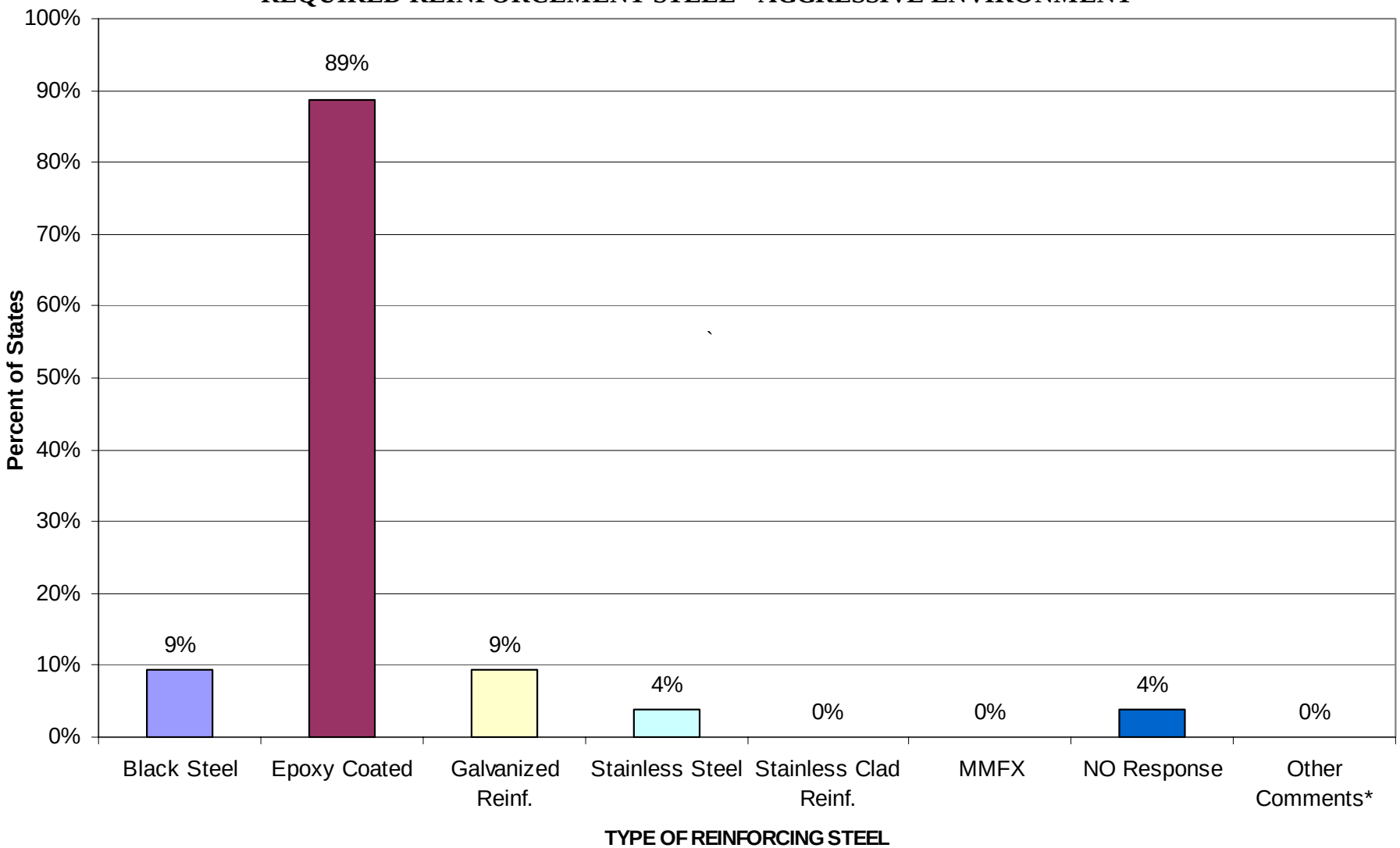
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



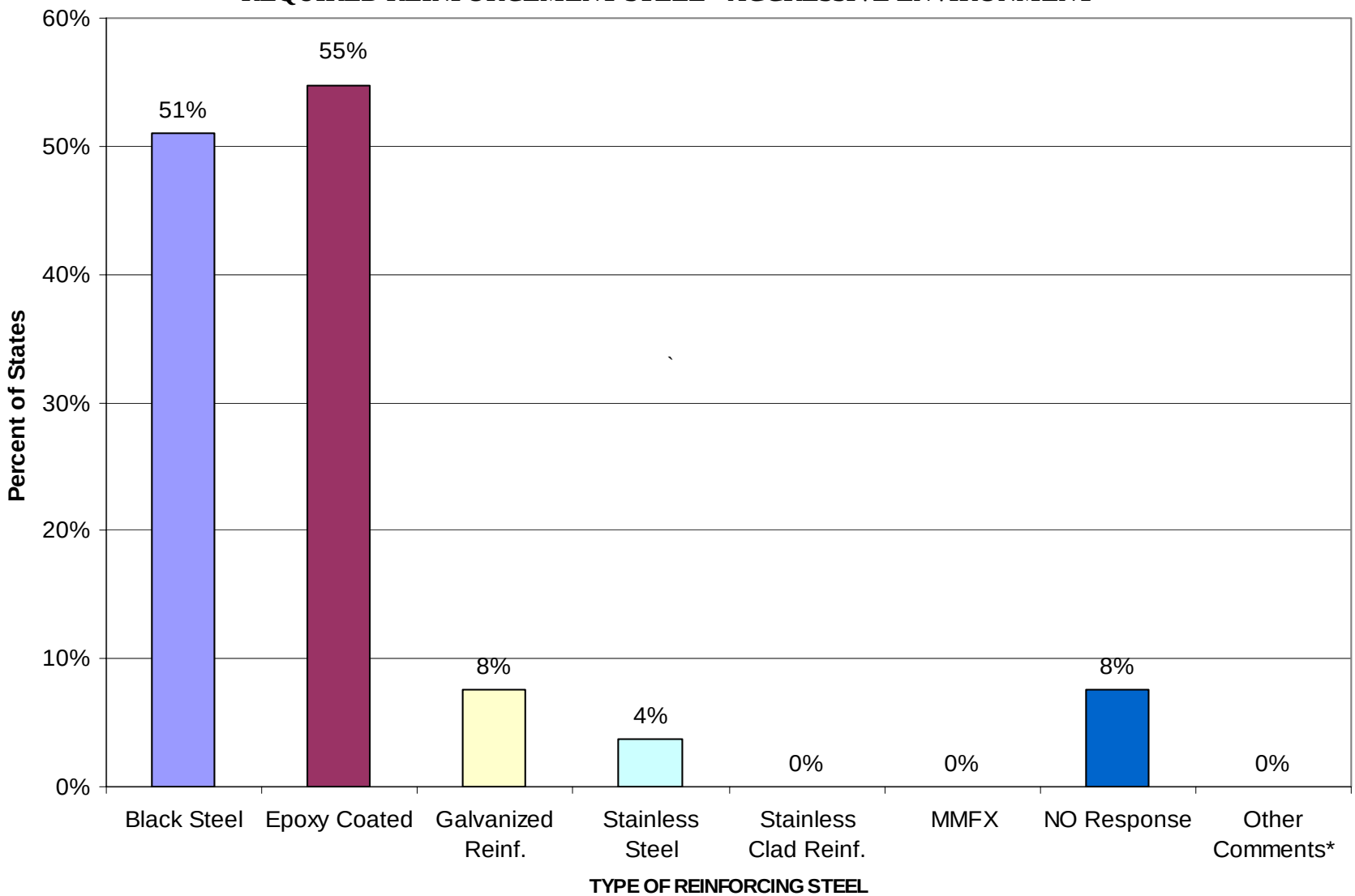
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 6 - REQUIRED REINFORCING STEEL									
STRUCTURAL ELEMENT	TYPE REINFORCING STEEL Part 4 - Aggressive Environment								
	BS	ECS	GS	SS	SCD	MMF X	No Response	Other Comments *	Not Used
Decks – Top	9%	89%	9%	4%	0%	0%	4%	0%	0%
Decks – Bottom	21%	77%	9%	4%	0%	0%	4%	0%	0%
Reinforced Concrete Beams	32%	43%	6%	4%	0%	0%	23%	0%	6%
Prestressed Concrete Beams, CIP	28%	42%	4%	4%	0%	0%	25%	0%	11%
Prestressed Concrete Beams, Precast	51%	55%	8%	4%	0%	0%	8%	0%	0%
Substructure – Piers	47%	57%	11%	2%	0%	0%	4%	0%	2%
Substructure – Abutments	47%	57%	9%	2%	0%	0%	4%	0%	0%
Substructure - Footings	57%	40%	9%	2%	0%	0%	4%	0%	0%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



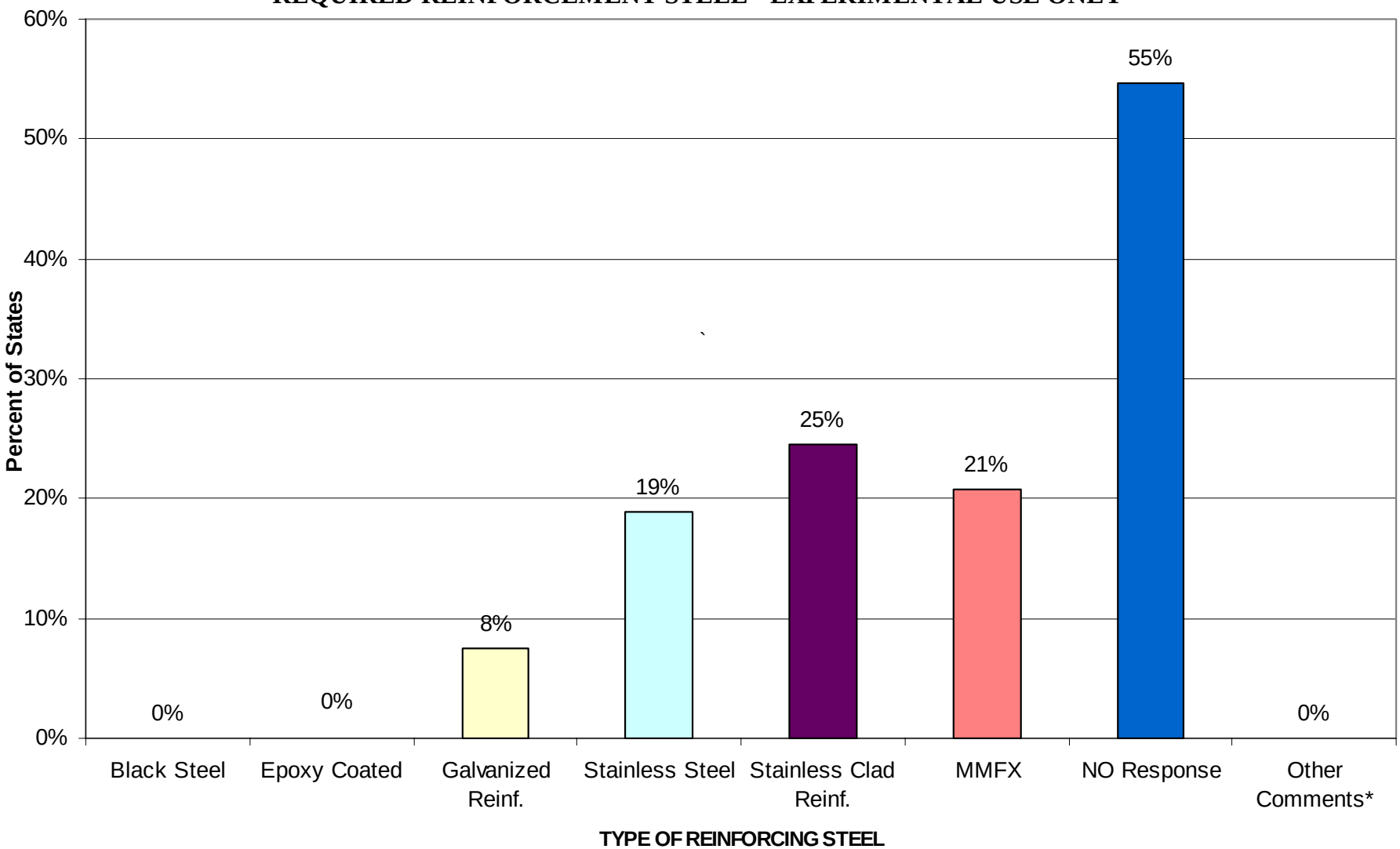
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



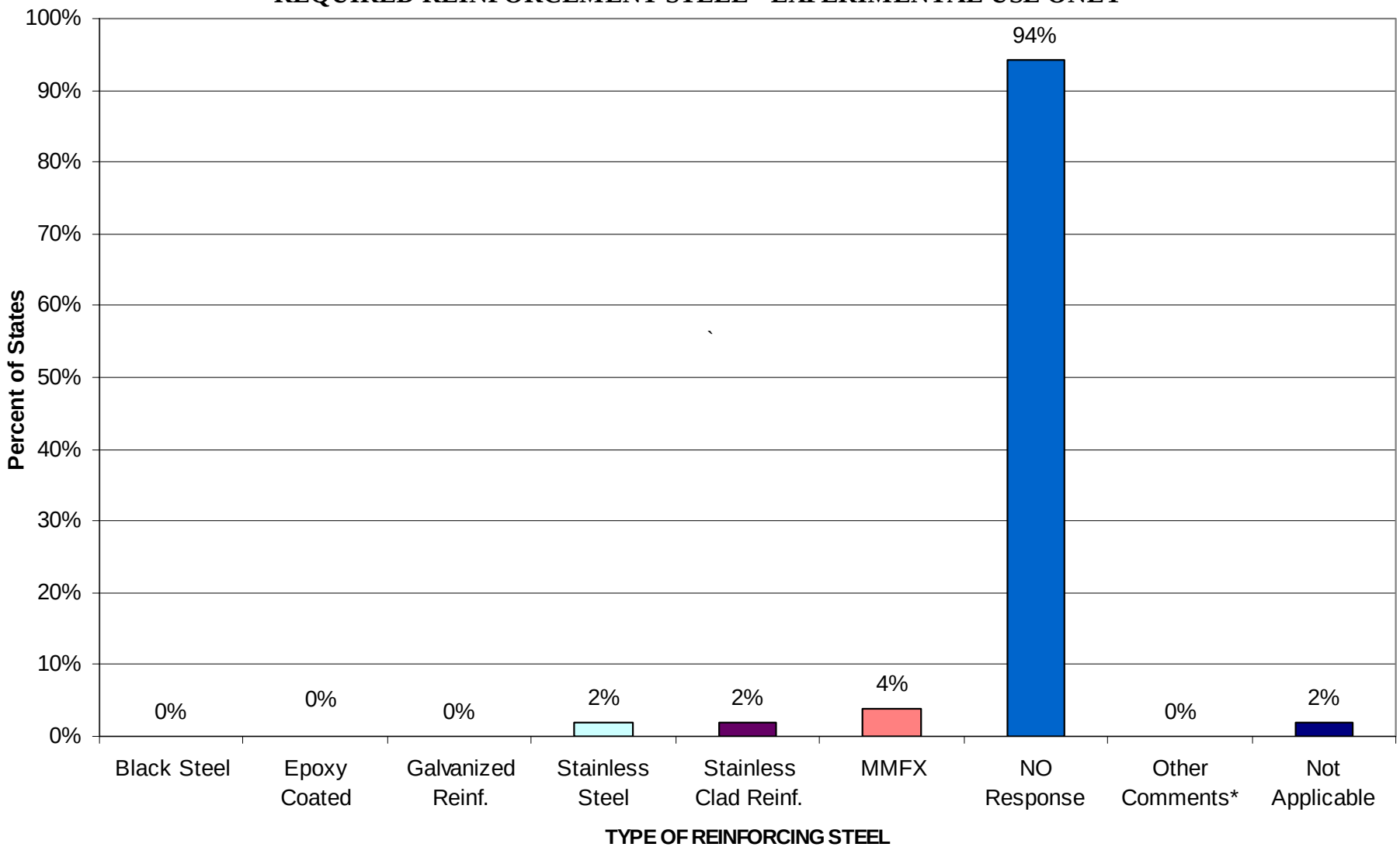
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 6 - REQUIRED REINFORCING STEEL									
STRUCTURAL ELEMENT	TYPE REINFORCING STEEL Part 5 – Experimental Use								
	BS	ECS	GS	SS	SCD	MMF X	No Response	Other Comments*	Not Used
Decks – Top	0%	0%	8%	19%	25%	21%	55%	0%	0%
Decks – Bottom	0%	0%	6%	17%	23%	21%	55%	0%	0%
Reinforced Concrete Beams	0%	0%	0%	4%	4%	2%	92%	0%	4%
Prestressed Concrete Beams, CIP	0%	0%	0%	2%	2%	2%	94%	0%	4%
Prestressed Concrete Beams, Precast	0%	0%	0%	2%	2%	4%	94%	0%	2%
Substructure – Piers	2%	0%	4%	6%	6%	8%	85%	0%	2%
Substructure – Abutments	2%	0%	2%	4%	4%	6%	89%	0%	2%
Substructure - Footings	2%	0%	0%	4%	4%	6%	91%	0%	2%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 7 & 8		% of 53* States that responded <YES>
# 7	*Is there a limit on the percent of alkali allowed in the cement? [YES=1, NO=0]*	66%
# 8 - Part 1	*Are the aggregates tested for reactivity? [YES=1, NO=0]*	64%
# 8 - Part 2	*How many sources of aggregates? [YES=1, NO=0]*	66%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 9	PERMEABILITY RANGE (Coulombs)	
Structural Element	**Non-Aggressive Environment Part 1**	**Aggressive Environment Part 2**
Bridge Decks	750 - 4000	750 - 4000
Prestressed Concrete Members	1000 - 2500	800 - 2500
Substructure Elements	1000 - 4000	800 - 4000
Pavements	2000 - 3500	2000 - 3500

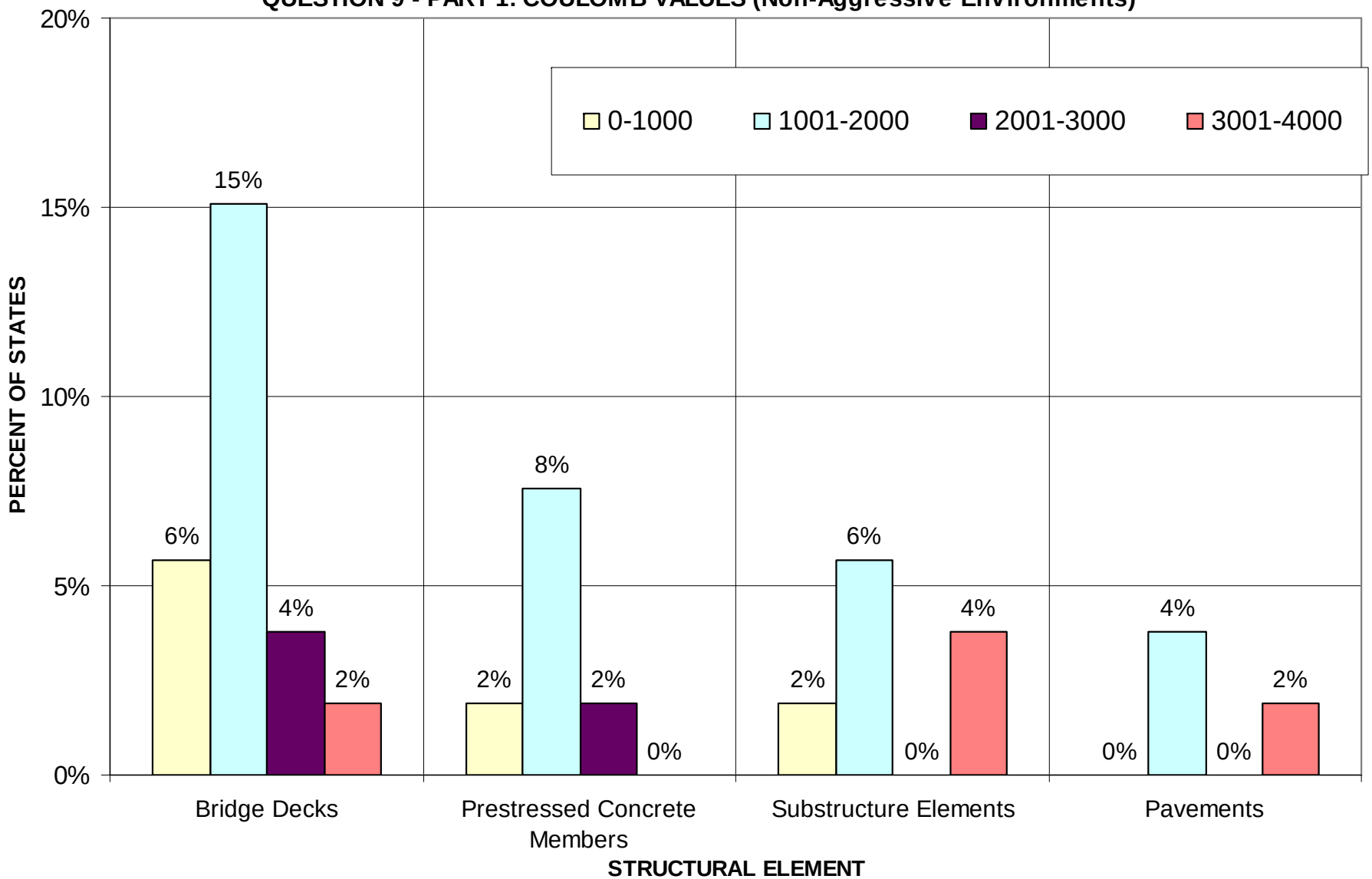
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 9	BRIDGE DECKS		PRESTRESSED CONCRETE MEMBERS	
Coulomb Range	Number of States		Number of States	
	Non-Aggressive Environment	Aggressive Environment	Non-Aggressive Environment	Aggressive Environment
	Part 1	Part 2	Part 1	Part 2
0-1000	3	7	1	4
1001-2000	8	11	4	4
2001-3000	2	1	1	2
3001-4000	1	1	0	0

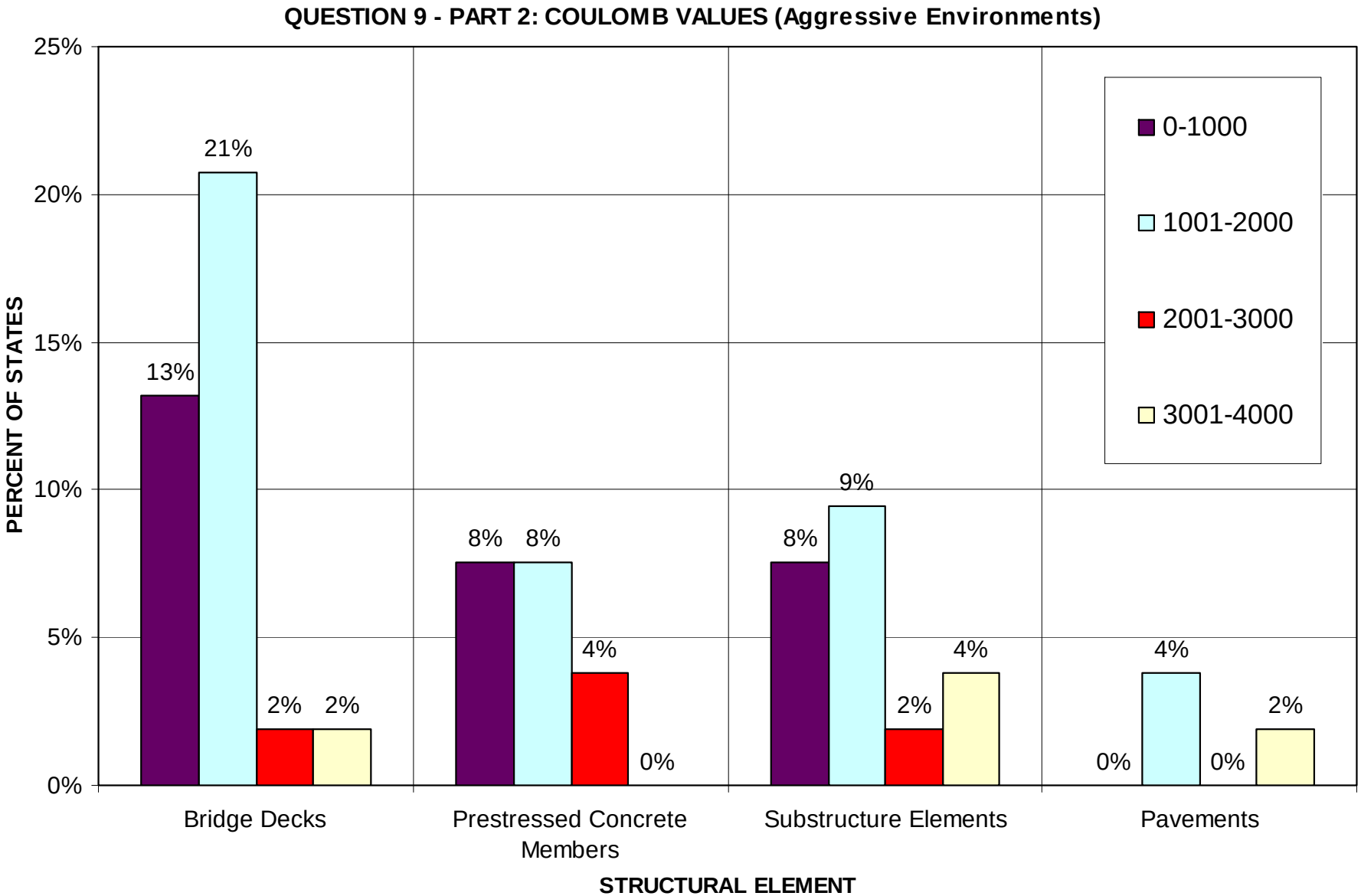
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 9	SUBSTRUCTURE ELEMENTS		PAVEMENT ELEMENTS	
Coulomb Range	Number of States		Number of States	
	Non-Aggressive Environment Part 1	Aggressive Environment Part 2	Non-Aggressive Environment Part 1	Aggressive Environment Part 2
0-1000	1	4	0	0
1001-2000	3	5	2	2
2001-3000	0	1	0	0
3001-4000	2	2	1	1

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



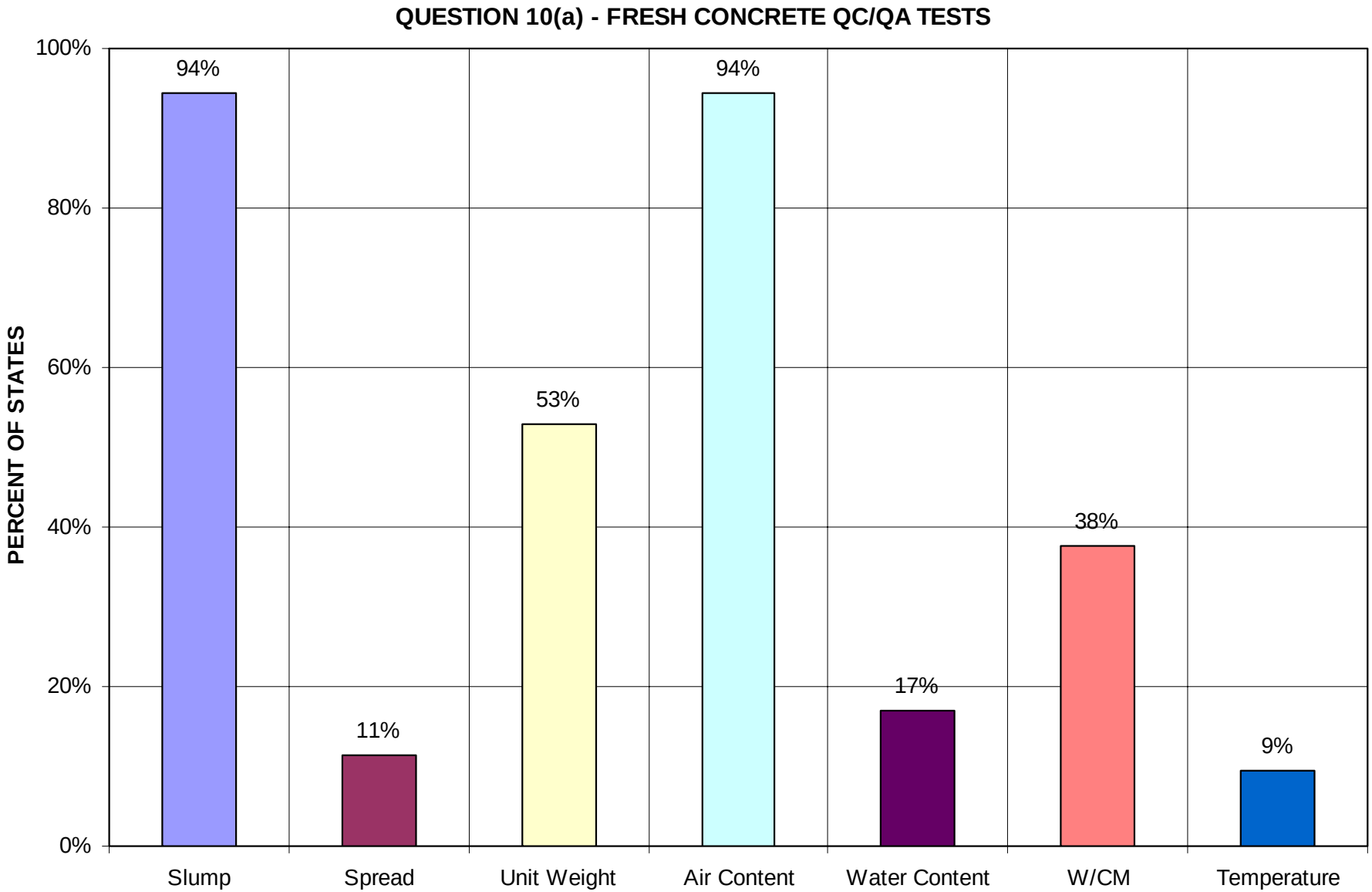
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 10(a)	
What QC/QA Test do you specify?	**% of 53* States that responded <YES>**
Fresh Concrete	
Slump	94%
Spread	11%
Unit Weight	53%
Air Content	94%
Water Content	17%
W/CM	38%
Temperature	9%

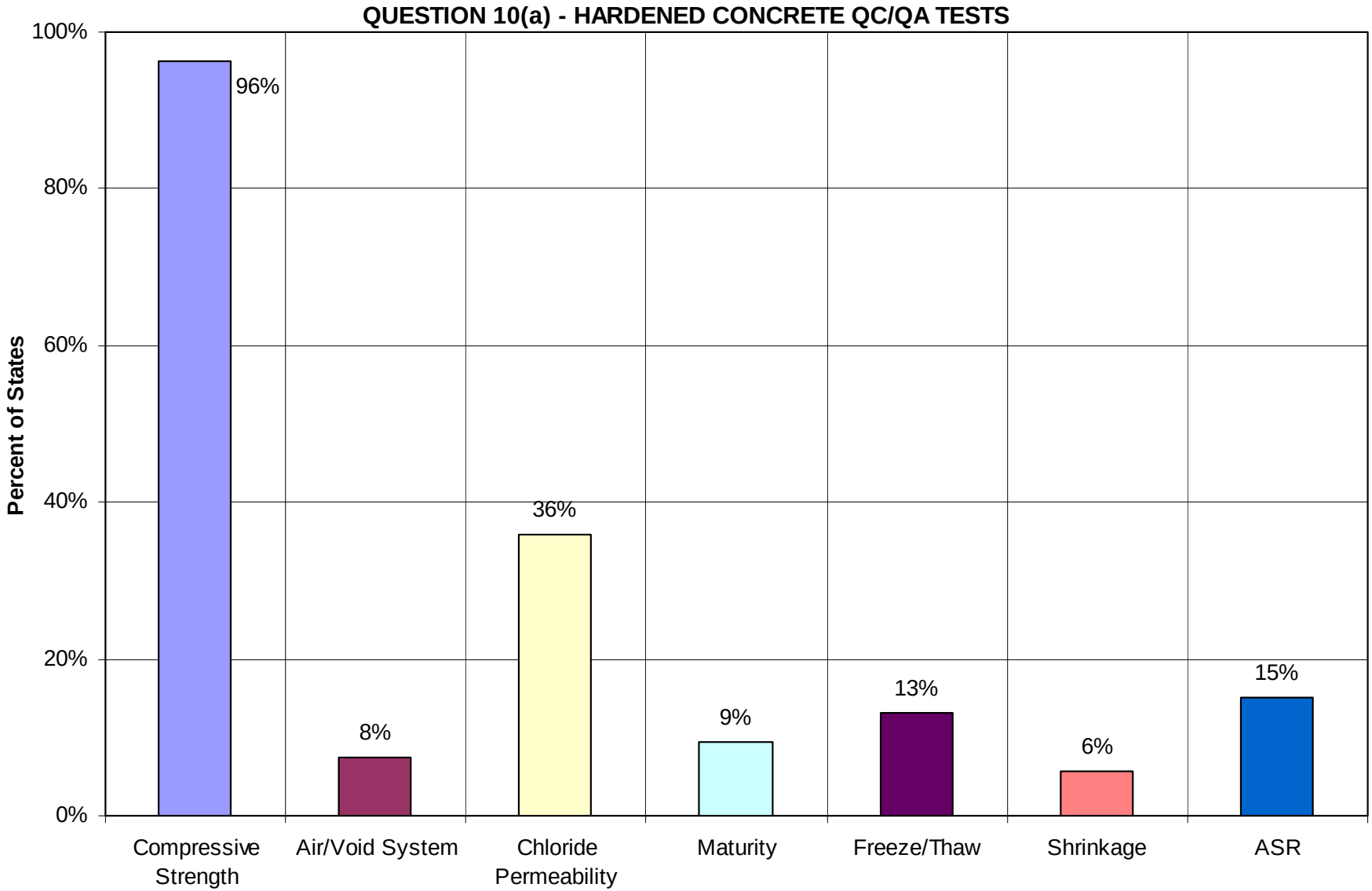
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

What QC/QA Test do you specify?	% of 53* States that responded <YES>
Hardened Concrete	
Compressive Strength	96%
Air/Void System	8%
Chloride Permeability	36%
Maturity	9%
Freeze/Thaw	13%
Shrinkage	6%
ASR	15%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 10(b)	% of 53* States that responded <YES>
What are your acceptance criteria for cracks? (i.e., Do you have an acceptance criteria for cracks?)	13%

Question 10 (c)	% of 53* States that responded <YES>
Do you specify pre-construction mock-ups?	36%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 10(d) - Do you specify design properties at (##) days … ?	% of 53* States that responded <YES>
28 days	98%
56 days	34%
Other Duration	6%

Question 10(e)	% of 53* States that responded <YES>
Do you allow 4x8 cylinders for compressive strength tests?	57%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 10(f) – What types of end-caps do you specify/allow …?	% of 53* States that responded <YES>
Sulfur	77%
Neoprene	83%
Ground Ends	17%

Question 10(g)	% of 53* States that responded <YES>
Do you specify match-cured cylinders?	30%

Question 10(h)	% of 53* States that responded <YES>
How do you enforce/monitor wet-water curing?	85%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 10(i)	% of 53* States that responded <YES>
Do you require warrantees against defects – e.g. bridge deck cracking?	8%

Question 10(j)	% of 53* States that responded <YES>
What is your experience/evaluation/specification regarding the Microwave Test for w/cm? (i.e., Do you have experience…)	13%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

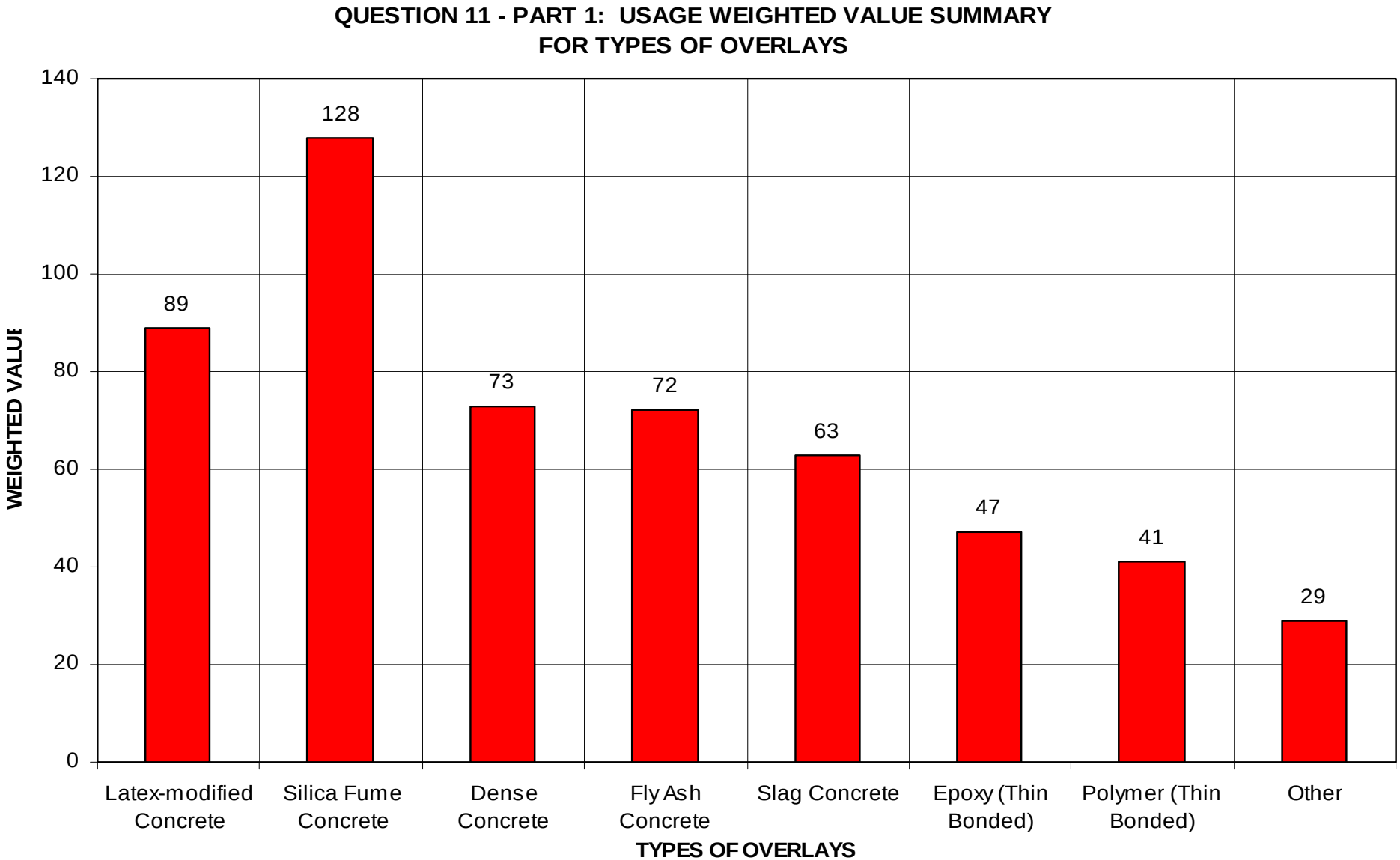
QUESTION 11 - Part 1:
USAGE (Range from 1 to 5 with 1 = rare and 5 = often)

Type of Overlay	1	2	3	4	5	WEIGHTED SUM
Latex-modified Concrete	51%	16%	14%	12%	7%	89
Silica Fume Concrete	36%	11%	11%	18%	24%	128
Dense Concrete	56%	17%	11%	3%	14%	73
Fly Ash Concrete	45%	17%	3%	14%	21%	72
Slag Concrete	59%	7%	7%	14%	14%	63
Epoxy (Thin Bonded)	74%	20%	3%	3%	0%	47
Polymer (Thin Bonded)	77%	17%	0%	7%	0%	41
Other	54%	8%	15%	8%	15%	29

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 11 - Part 2	COMMENTS ON PERFORMACE			
Type of Overlay	**EXCELLENT**	**GOOD**	**POOR**	**NO RATING**
Latex-modified Concrete	21%	26%	4%	49%
Silica Fume Concrete	15%	38%	6%	42%
Dense Concrete	9%	19%	0%	72%
Fly Ash Concrete	19%	9%	0%	72%
Slag Concrete	9%	13%	2%	75%
Epoxy (Thin Bonded)	2%	21%	6%	72%
Polymer (Thin Bonded)	4%	9%	6%	81%
Other	4%	6%	0%	91%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



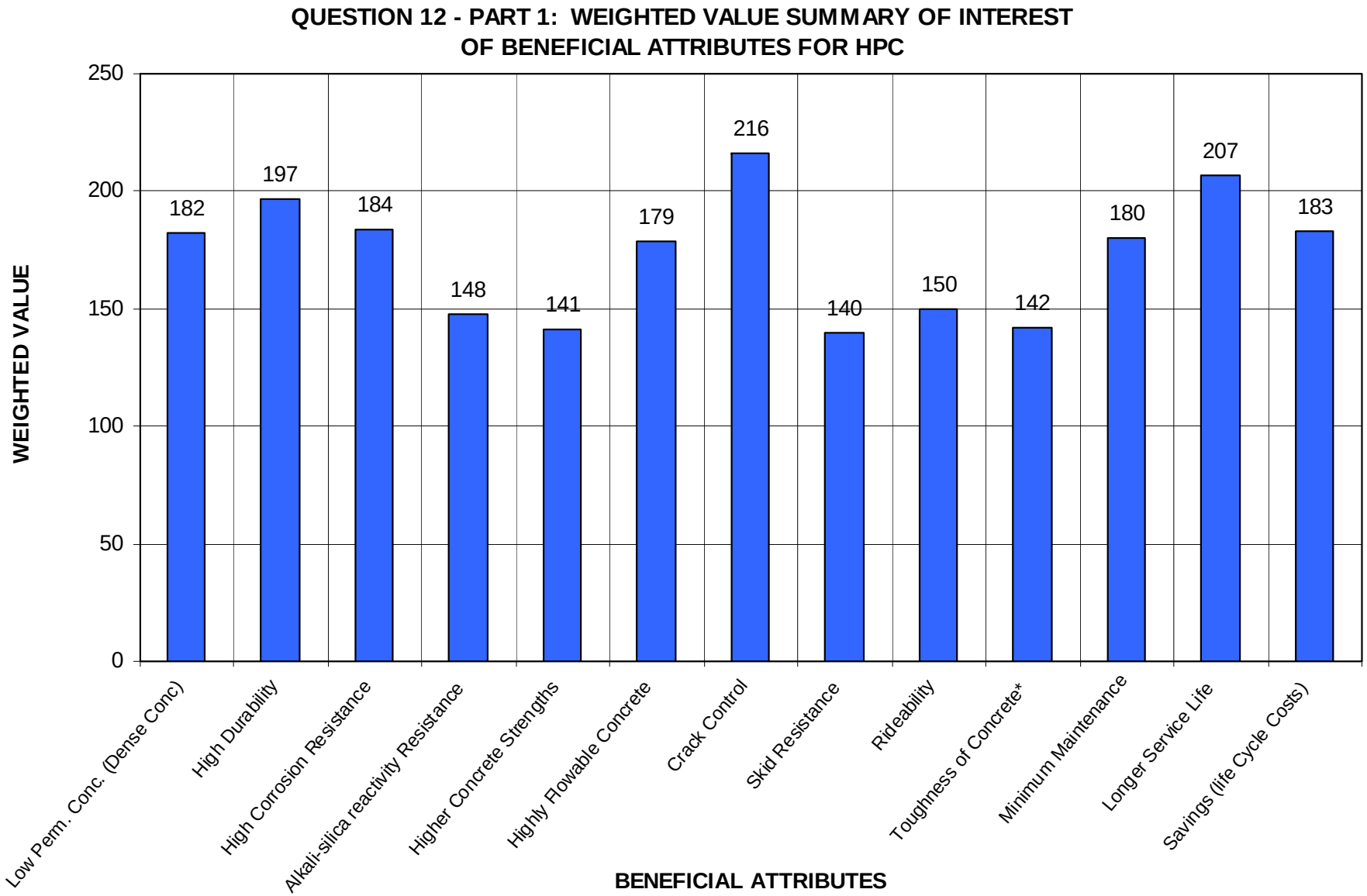
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

Question 12 - PART 1						
Beneficial Attributes	**INTEREST LEVEL (1 = LOW, 5 = VERY HIGH**					**WEIGHTED SUM - BENEFICIAL ATTRIBUTES**
	1	**2**	**3**	**4**	**5**	
Low Perm. Conc. (Dense Conc)	19%	11%	17%	13%	40%	182
High Durability	13%	6%	19%	21%	42%	197
High Corrosion Resistance	9%	17%	23%	19%	32%	184
Alkali-silica reactivity Resistance	25%	17%	27%	10%	21%	148
Higher Concrete Strengths	19%	23%	43%	4%	11%	141
Highly Flowable Concrete	9%	13%	28%	28%	21%	179
Crack Control	2%	8%	23%	17%	51%	216
Skid Resistance	14%	27%	39%	10%	10%	140
Rideability	17%	19%	35%	15%	13%	150
Toughness of Concrete*	16%	22%	39%	16%	8%	142
Minimum Maintenance	8%	10%	35%	25%	23%	180
Longer Service Life	8%	4%	23%	23%	43%	207
Savings (life Cycle Costs)	12%	8%	27%	25%	29%	183

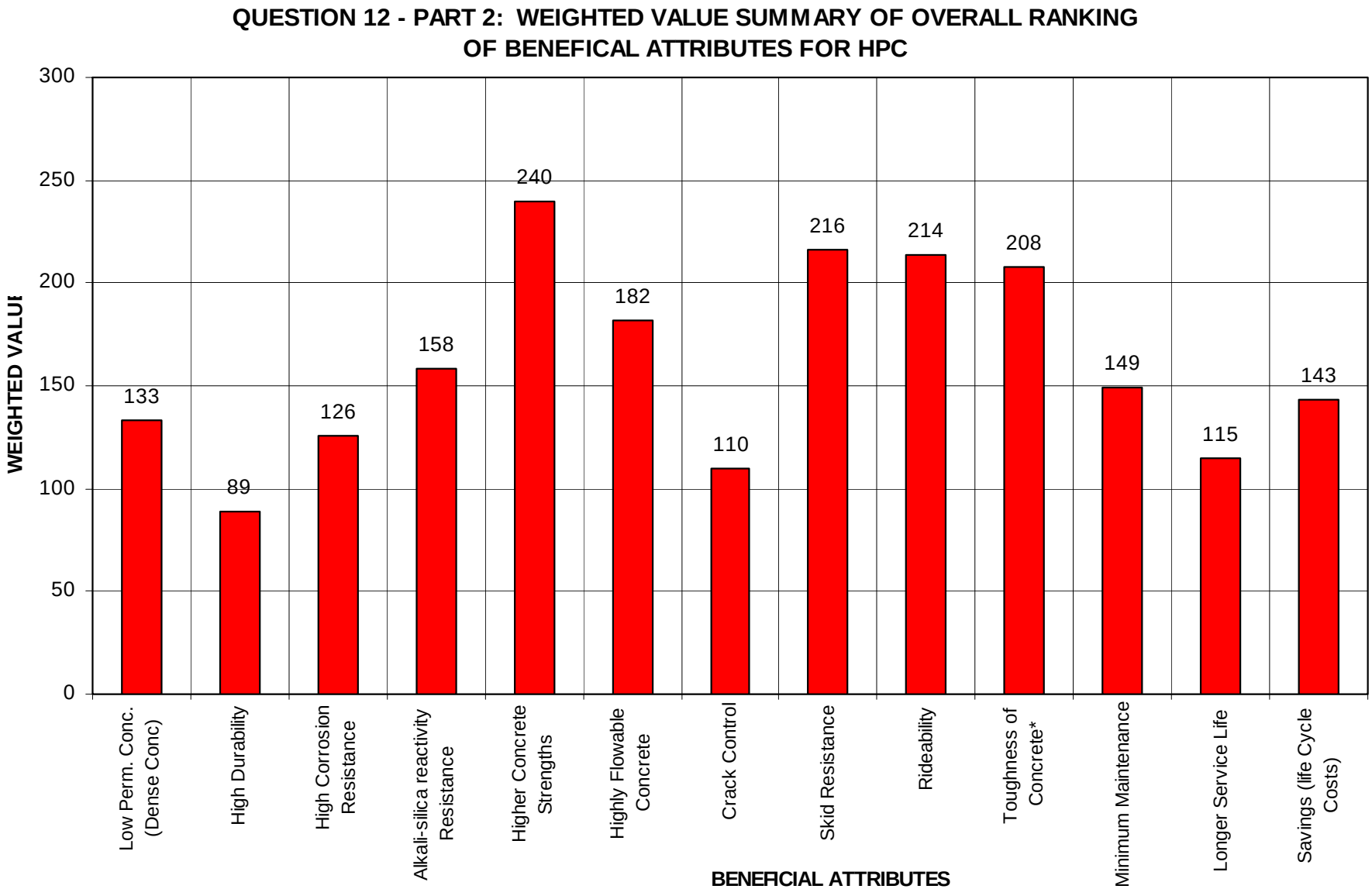
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 12 - Part 2														
BENEFICIAL ATTRIBUTES	Overall Ranking													WEIGHTED SUM OVERALL RANKING
	1	2	3	4	5	6	7	8	9	10	11	12	13	
Low Perm. Conc. (Dense Conc)	15%	12%	23%	12%	4%	4%	0%	4%	12%	0%	8%	4%	4%	133
High Durability	38%	19%	12%	0%	12%	0%	4%	8%	0%	4%	0%	4%	0%	89
High Corrosion Resistance	4%	19%	8%	19%	15%	8%	12%	8%	0%	8%	0%	0%	0%	126
Alkali-silica reactivity Resistance	5%	5%	18%	0%	14%	5%	5%	14%	9%	0%	5%	14%	9%	158
Higher Concrete Strengths	0%	0%	0%	0%	8%	4%	4%	4%	13%	13%	33%	4%	17%	240
Highly Flowable Concrete	4%	13%	0%	9%	4%	4%	13%	0%	13%	4%	4%	17%	13%	182
Crack Control	27%	8%	12%	12%	12%	12%	4%	4%	4%	4%	4%	0%	0%	110
Skid Resistance	0%	0%	0%	4%	4%	4%	13%	4%	17%	9%	22%	17%	4%	216
Rideability	0%	0%	0%	4%	4%	17%	4%	8%	8%	29%	13%	8%	4%	214
*Toughness of Concrete**	0%	0%	0%	13%	8%	4%	8%	13%	13%	8%	17%	4%	13%	208
Minimum Maintenance	4%	4%	4%	13%	9%	17%	9%	13%	9%	13%	4%	0%	0%	149
Longer Service Life	13%	13%	17%	13%	8%	8%	13%	4%	4%	0%	8%	0%	0%	115
Savings (life Cycle Costs)	0%	9%	9%	13%	13%	13%	13%	13%	0%	4%	13%	0%	0%	143

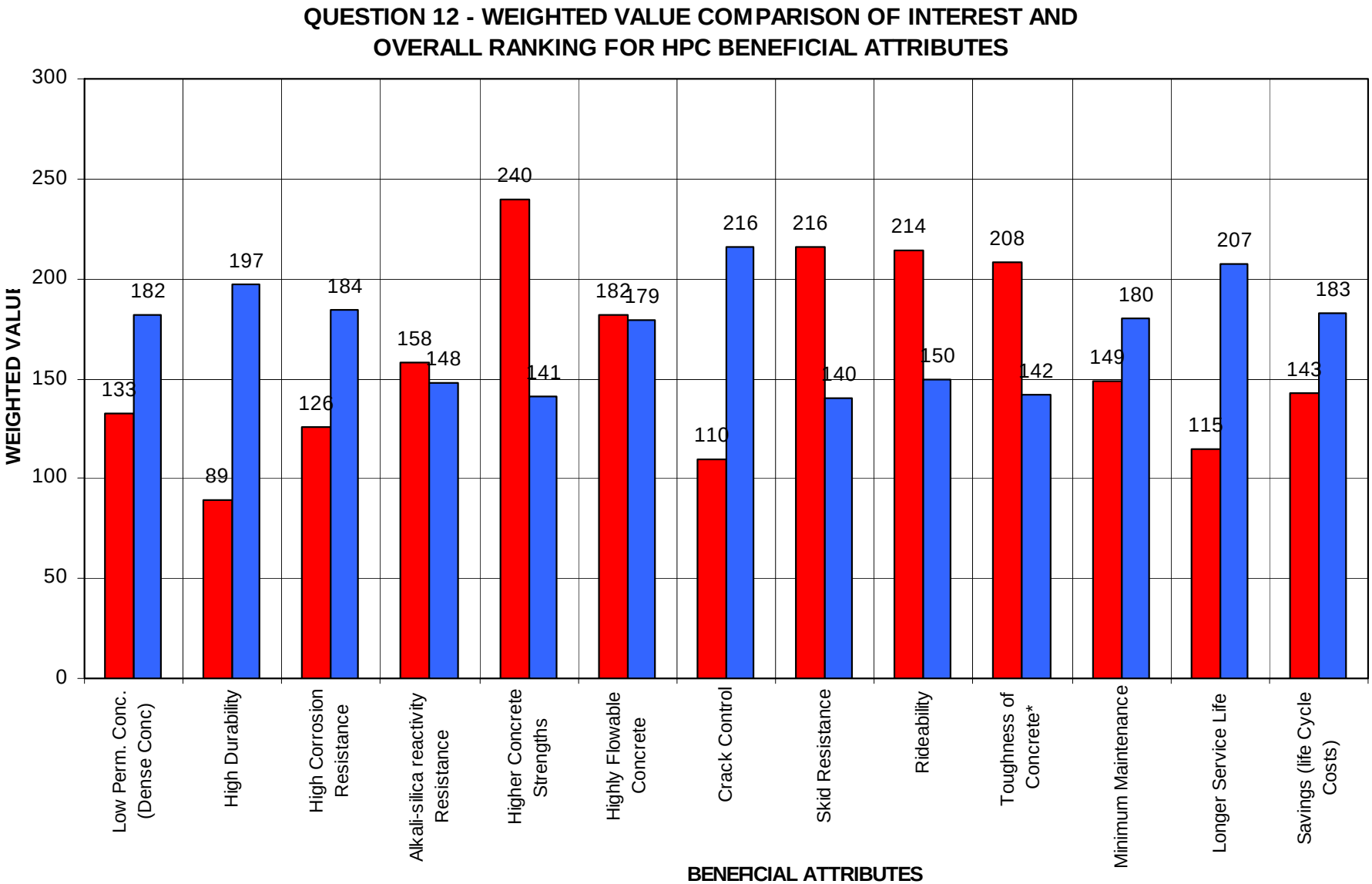
HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS



HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 13	
Responsible Individual	**% of 53* States that responded <YES>**
Materials	98%
Construction	79%
Pavement	45%
Structures	89%
Research	55%

HIGH PERFORMANCE CONCRETE NATIONWIDE SURVEY (2003) RESULTS

QUESTION 14				
SHRP Products	**% of 53* States that responded <YES>**	**% of 53* States that responded <NO>**	**% of 53* States that responded <Unknown>**	**% of 53* States that responded <Implemented >**
2005	27%	40%	31%	2%
2014	46%	21%	15%	17%
2017	20%	45%	18%	18%
2036	20%	30%	42%	8%

QUESTIONS?
THANK YOU